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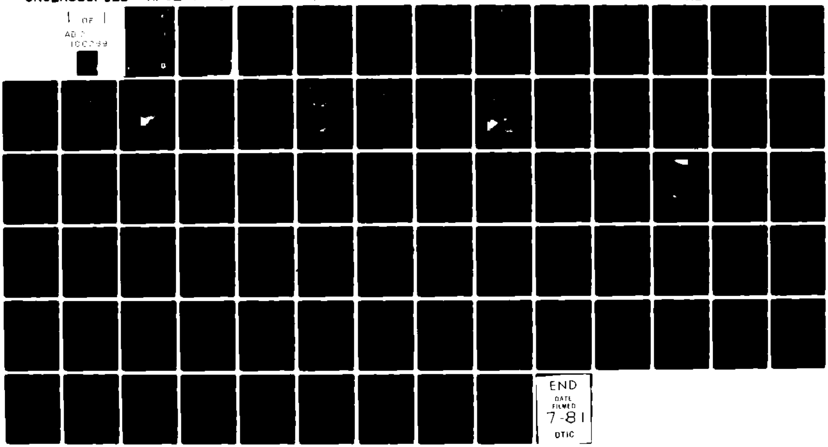

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Cirrus Particle Distribution Study, Part 7

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16 October 1980

METEOROLOGY DIVISION PROJECT 2310
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AIR FORCE SYSTEMS COMMAND, USAF

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FOR THE COMMANDER

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Chief Scientist

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Particle data obtained during C-130 cirrus sampling flights on 28 and 29 January and 2 February 1979 over the southwestern United States are described. The first flight sampled cirriform clouds ahead of a developing storm; the second flight obtained data in the tops of the cirriform clouds of a fully developed storm; and the third examined cirrus formed by a weak polar front and strong upper level winds. All flights sampled a variety of densities of cirrus; however, those sampled on 29 January, were the most complex

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20. Abstract (Continued)

and also at the lowest altitude. This flight provided numerous samples having as many as 350,000 particles per cubic meter in the 47 to 4700-μm size range. The largest particle sizes were generally less than 1100 μm, but some cirrus particles as large as 2.5 mm were detected at altitudes between 5.9 and 7.7 km. Generally, the calculated ice water content (IWS) values were 0.04 g m^{-3} or less, with a maximum of 0.10 g m^{-3} in the active storm situation. On the other two days, the cirrus was of varying density with most particles less than 1400 μm and IWCs of 0.03 g m^{-3} or less. Particles as large as 2.5 mm were detected in the cirrus on all three flights. The in-flight meteorologist's characterization of heavy or thin clouds is better correlated with total particle number than particle size. Several atmospheric and particle spectral properties are tabulated for consecutive 15-sec data samples for the 3 flights.

Cloud-free periods were examined; some showed the presence of the two types of subvisible cirrus. The first type consisted of a background of small particles less than a few tens of microns; the second type consisted of large subvisible cirrus particles of the order of 100 μm or larger. The density of subvisible particles larger than 100 μm during a cloud-free period on 2 February 1979 was 7 μm^{-3}.

Preface

The authors extend their appreciation to the many persons responsible for the successful acquisition and processing of the data presented in this report. The AFGL technicians who flew on the C-130 were SMSgt Thomas Moraski, MSgt James Bush, MSgt Stephen Crist, SrA Grant Matsuoka, SrA Lou Ames, Jr. and A1C Wayne Domeier. The 4950th Test Wing pilots, crew, and technicians did an outstanding job in flying and maintaining the airplane. Most of the computer processing of the large volume of data was expertly accomplished by Mr. Michael Francis and Mr. James Lally of Digital Programming Services, Inc. The authors also thank Mr. Morton Glass for his helpful suggestions, Ms Barbara Main for preparing the illustrations, and Mrs. Patricia Sheehy for her excellent typing support.

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Cirrus Particle Distribution Study, Part 7

1. INTRODUCTION

This report continues the presentation of data from a series of cirrus sampling flights made for the Air Force Weapons Laboratory (AFWL) under the Advanced Radiation Technology (ART) program. The flights in the series also provide information for a study of cirrus being conducted for the Air Force Office of Scientific Research (AFOSR). In this report, the data were gathered in the course of three flights, 28 and 29 January 1979, and 2 February 1979, from Kirtland Air Force Base, Albuquerque, New Mexico.

A summary of the series follows: The first report described some of the sampling instrumentation (Varley)[1] available on the specially equipped MC-130E (maintained and flown by personnel of the 4950th Test Wing) used in all the flights; this first report also considered data acquired at 7.6 km before an approching upper level trough. The second report, by Varley and Brooks,[2] presented particle spectra for heavy cirrostratus and thin cirrus, whereas the third report (Varley)[3] described a flight that acquired primarily very small crystals (<~ 30 μm) in a high haze-like cloud layer.

(Received for publication 16 October 1980)

Because of the number of references cited above, they will not be listed here. See References, page 53.

[illegible] has been reported in the fourth part of this series by Varley and Barnes[4] [illegible] cloud that appeared related to a band of [illegible]. In the [illegible] report, by Cohen,[5] the altostratus and cirrostratus [illegible] strong [illegible] the winds [illegible] generally less than 40 [illegible]. The sixth report, by Cohen and Barnes,[6] [illegible] cirrus associated with [illegible].

The largest particle [illegible] clouds [illegible] between 0.001 and 0.1 [illegible] the latter values [illegible]

[illegible] 40,000 [illegible] 4,000 [illegible]

[illegible] of crystals in cirrus generally [illegible] with increasing [illegible]. For other flights, Heymsfield[7] reported [illegible] of 4,000 to 40,000 m^{-3} in cirrus uncinus and cirrostratus. Much of the difference in these values is a result of the different particle sizes considered in each over-all number count.

This report has two main purposes: First, to add more particle data to the paucity of information that now exists on cirrus particle spectra and their

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4. Varley, D.J., and Barnes, A.A., Jr. (1979) Cirrus Particle Distribution Study, Part 4, AFGL-TR-79-0134, Air Force Surveys in Geophysics 413, AD A074 763, 91 pp.

5. Cohen, I.D. (1979) Cirrus Particles Distribution Study, Part 5, AFGL-TR-79-0155, Air Force Surveys in Geophysics 414, AD 077 361, 81 pp.

6. Cohen, I.D., and Barnes, A.A., Jr. (1980) Cirrus Particle Distribution Study, Part 6, AFGL-TR-80-0261, Air Force Surveys in Geophysics 430, (in press).

7. Heymsfield, A. and Knollenberg, R. (1972) Properties of cirrus generating cells, J. Atmos. Sci. 29:1358-1366.

8. Heymsfield, A. (1974) Ice crystal growth in deep cirrus systems, [illegible] Conf. on Cloud Phys., [illegible], 311-316.

9. Heymsfield, A. [illegible] cirrus uncinus generating cells [illegible] [illegible] clouds, [illegible] 1-306.

variations sensed, to provide information on subvisible cirrus. In our study of the former, more emphasis is placed on number concentration of the ice samples, on correlating contributions of ice water content with particular particle sizes, and on the correlation of "form factors" with each spectrum.

2. INSTRUMENTATION AND DATA PROCESSING

The primary cloud physics instrumentation used during the three flights discussed in this report include: PMS (Particle Measuring Systems, Inc.) one-dimensional (1-D) and two dimensional (2-D) particle spectrometers, a PMS axial scattering spectrometer probe (ASSP), and a formvar replicating system. Other recorded data include outside air temperature and altitude, as well as aircraft heading and airspeed.

The PMS spectrometers are widely used instruments that have been described, for example, by Knollenberg[10, 11] and Cunningham.[12] After the particle data were acquired and recorded on magnetic tape aboard the sampling aircraft, they were computer processed, as described by Cunningham,[12] Varley[1] and Varley and Barnes[4] in previous parts of this study. Essentially, the equivalent melted diameter of all recorded ice crystals is determined using AFGL "melting" equations for standard particle types. Calculations of ice water content (IWC) are then made based on the number of particles recorded in each channel of the spectrometer probes.

The melting equations used for all data in this report are the same as those used for the AFGL type "bullet rosettes." This type was selected based on a review of the 2-D shadowgraph data from each flight. Studies by Heymsfield and Knollenberg[7] and Heymsfield[9] have shown that bullet rosettes and bullets are the most common crystal type in cirriform cloudiness. While the bullet rosette is most easily recognized, we strongly agree with the finding of Hobbs and Atkinson[13]

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10. Knollenberg, R. (1975) The Response of Optical Array Spectrometers to Ice and Snow: A Study of Probe Size to Crystal Mass Relationships, AFGL-TR-75-0494, AD A020 276.

11. Knollenberg, R. (1976) Three new instruments for cloud physics measurements: the 2-D spectrometer, the forward scattering probe, and the active scattering spectrometer. Preprints of Intnl. Cld. Physics Conf., Boulder, Colorado, Amer. Meteor. Soc., 554-561.

12. Cunningham, R. (1978) Analysis of particle spectral data from optical array (PMS) 1-D and 2-D sensors. In Preprints of AMS Fourth Symposium on Meteorological Observations and Instrumentation, Denver, Colorado.

13. Hobbs, P.V., and Atkinson, D.G. (1976) The concentrations of ice particles in orographic clouds and cyclonic storms over the Cascade Mountains. J. Atmos. Sci. 33:1363-1374.

that most particle shapes in ice clouds are irregular, with reference to standard ice or snow particle classifications.

Values of microphysical variables in this report have been averaged over 15-sec periods, providing somewhat better resolution of cloud conditions than the 30-sec averaging employed in previous parts of this series. Brief descriptions of other types of data will be given as initially presented.

A discussion of the weather in the southwestern United States on 28 January to 2 February, the period covered by the three flights, follows. Flight and sample data will be discussed separately.

3. SYNOPTIC DISCUSSION FOR THE PERIOD 28 JANUARY TO 2 FEBRUARY 1979

During the morning of 28 January 1979, the weather in the southwestern United States was dominated by two low pressure areas. At 1200Z, one was located over southeastern California; the other was in Mexico, 120 miles south of El Paso, Texas. During the day, the first of those low pressure areas moved eastward into Arizona, while the other remained stationary. Southeast flow around the two lows brought moisture from the Gulf of Mexico into the system, causing both lows to intensify and a trough to form between them (see Figure 1). This development was aided by an upper air wave over the western United States. The position of this wave is seen in Figure 2. The Jet Stream followed the 9240-m contour, as can be seen by the 150-kt wind at El Paso, Texas. With the combination of southeast flow at low levels and west-south-west flow at high levels, the system continued to intensify. As the GOES-west satellite pictures show, (Figures 3 and 4) an extensive shield of clouds formed around the southern low pressure area. The flight of 28 January sampled the cirriform clouds on top of this cloud shield. The rawinsonde soundings shown in Figures 5 and 6 point out how the moisture in west Texas increased during the day on 28 January. During the next twelve hours, the two surface lows shown in Figure 1 merged and the two surface troughs developed into an occluded front.

During 29 January, this system deepened into an extensive storm. The position of this storm at 2100Z on 29 January 1979 is shown in Figure 7. The sampling flight of 29 January sampled cirriform clouds while the storm was at its greatest intensity. As the GOES-east satellite photos in Figures 8 and 9 show, an extensive cloud mass covered a large area ahead of the front extending from Texas through Oklahoma, Kansas, and Colorado to Wyoming. Rain and drizzle were observed in Texas and snow was reported throughout the rest of the area; most stations in the sampling area were reporting light, continuous snow. The upper air wave had

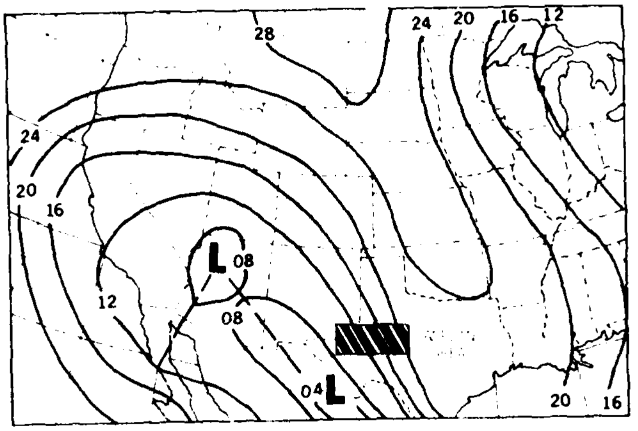


Figure 1. Surface Synoptic Chart at 2100Z, 28 January 1979. Add 1000 millibars to isobar values

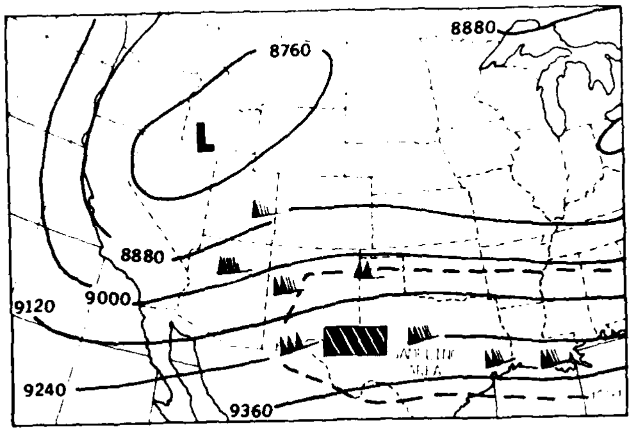


Figure 2. 300-mb Analysis at 1200Z, 28 January 1979. Contour values in geopotential meters

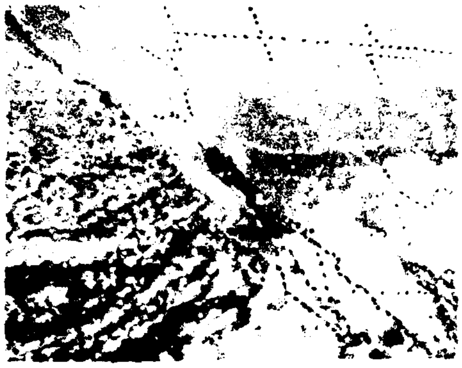


Figure 3. GOES-West Visible Picture Showing New Mexico and West Texas Area at 1815Z, 28 January 1979. Resolution: 2 nm

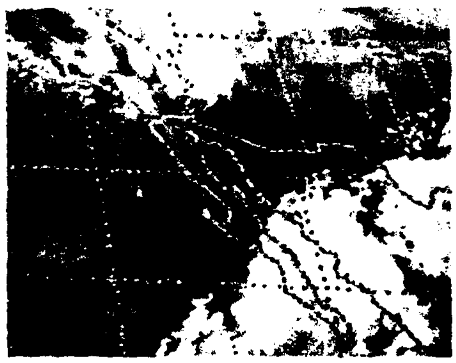
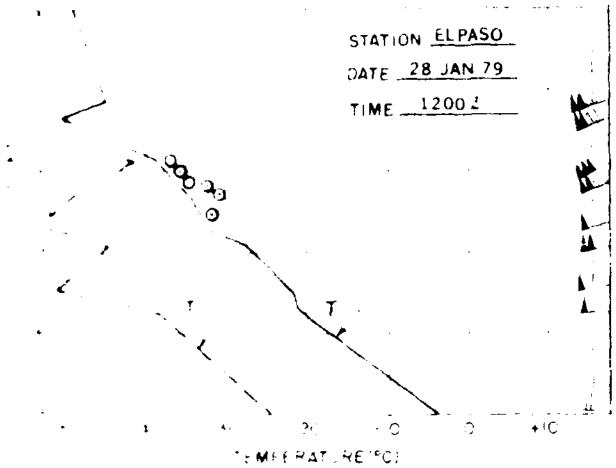


Figure 4. GOES-West Infrared Picture at 1815Z, 28 January 1979



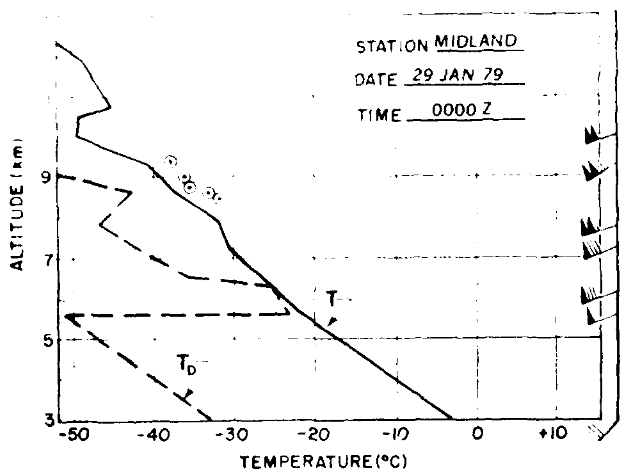


Figure 6. Midland, Texas 0000Z, 29 January 1979 sounding. Circles are C-130 temperature measurements as on El Paso plot. Tropopause was at 10.0 km MSL.

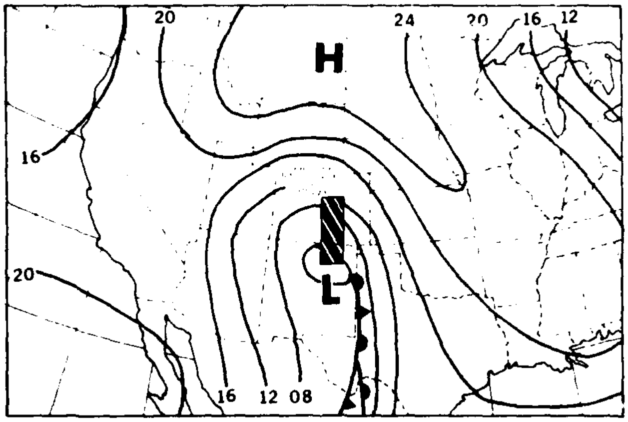


Figure 7. Surface Synoptic Chart at 2100Z, 29 January 1979. Add 1000 millibars to isobar values

deepened considerably, as can be seen in Figure 10. Figures 11 and 12 show the radiosonde soundings for Albuquerque, New Mexico, and Denver, Colorado. While Albuquerque was already well behind the front and thus clearing, the Denver radiosonde shows both a moist layer 6 km thick as well as the front that caused it (at 3 1/2 km), marked by a strong inversion and a wind shift. The westerly and northwesterly flow both aloft and at the surface brought rapid clearing to western New Mexico, and as the storm moved eastward, rapid clearing occurred in the sampling area. The upper air trough became stationary, and as the storm moved eastward, it weakened as dry air from a high pressure area, located in Montana (Figure 7) caused it to lose energy.

This continental high pressure area pushed southward and provided the New Mexico area with two days of clear weather until a complex system moved in from the Pacific Ocean. A weak Pacific cold front moved through southern California and Arizona on 31 January and passed through New Mexico on 1 February. Meanwhile, a second cold front formed over Nevada and Utah, as colder continental polar air pushed toward this area. By 1200Z on 2 February, the Pacific front was in the Texas Panhandle, while the polar front had moved to Central Utah and Central Colorado. As Figure 13 shows, by 2100Z on 2 February, the Pacific front had dissipated, while the polar front had moved into the Texas Panhandle and northern New Mexico. The cirrus in advance of this front was sampled during the flight of 2 February. As shown in Figure 14 (a GOES visible satellite photo), an extensive area of low cloud was moving south with the polar front. Figure 15 (the corresponding infrared photo) shows the

Figure 8. GOES-East Visible Photo of Cloud Conditions Over Southwest U.S. at 1901Z on 29 January 1979

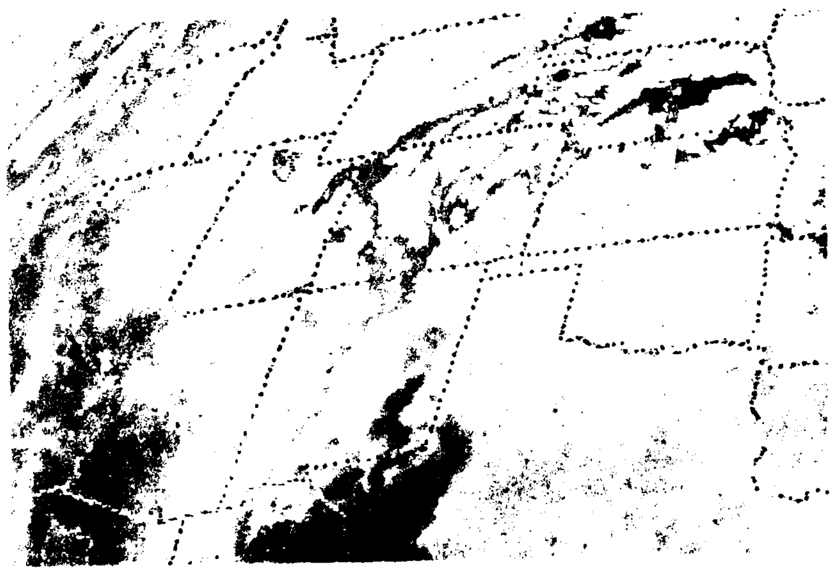


Figure 9. GOES-East Infrared Photo of Southwest U.S. at 1930Z on 29 January 1979

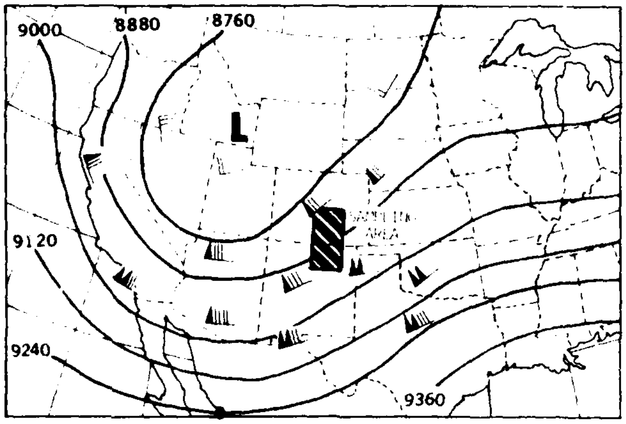


Figure 10. 300-mb Analysis 1200Z, 29 January 1979. Height in geopotential meters

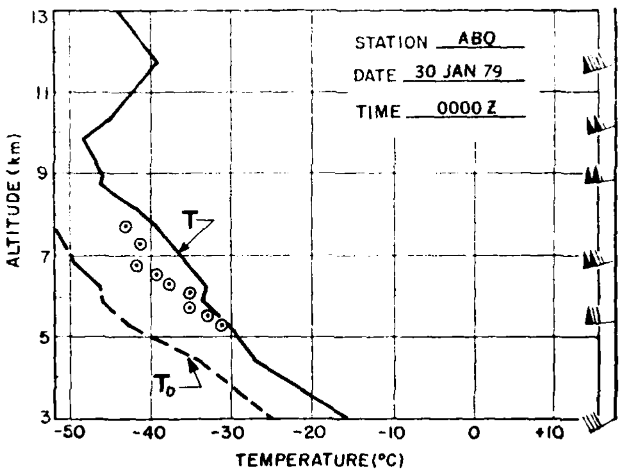


Figure 11. Albuquerque, N.M. Sounding 4 hr After 29 January 1979 Sampling. Circles are aircraft-measured temperatures along the flight track. Tropopause was at 9.8 km MSL

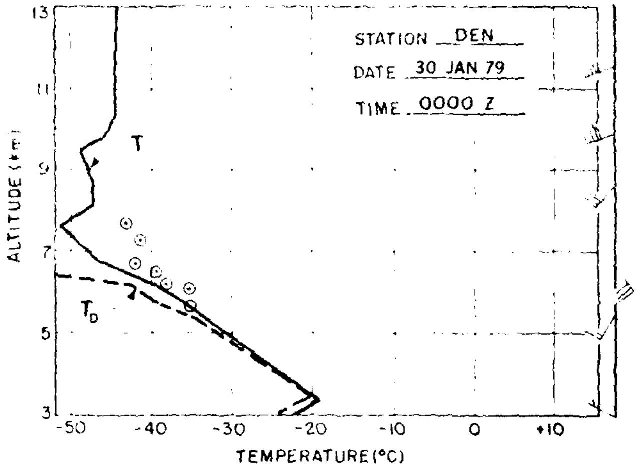


Figure 12. Denver, Colorado Sounding 4 hr After 29 January 1979 Sampling. Front is at 3 1/2 km. Circles are aircraft measured temperatures as on Albuquerque sounding. Tropopause was at 7.6 km MSL

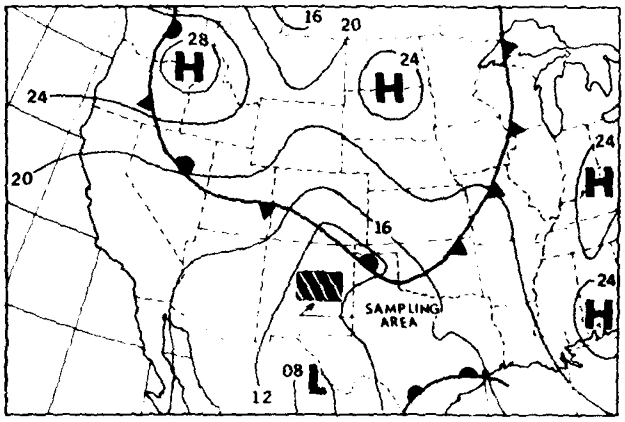


Figure 13. Surface Synoptic Chart at 2100Z, 2 February 1979. Add 1000 millibars to isobar values

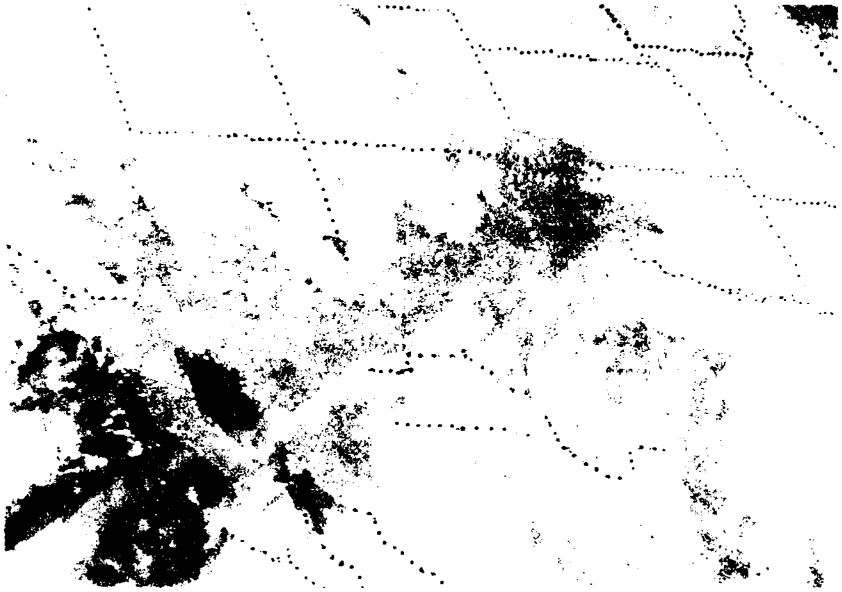


Figure 14. GOES-West Visible Photo Centered on New [illegible] at 204[illegible]Z, 2 February 1979

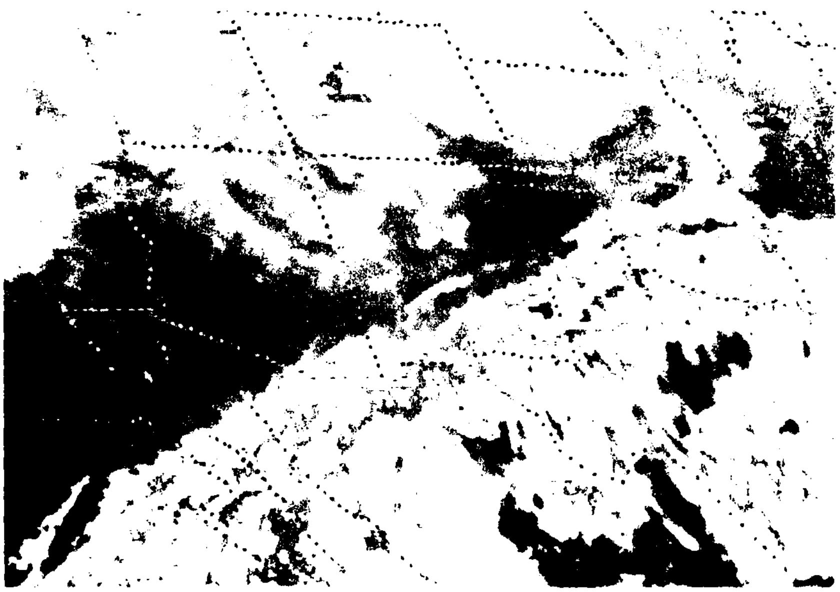


Figure 15. GOES Infrared Photo at 144[illegible]Z, 2 February 1979. This was last IR picture received before sampling 6 hr later

cirriform clouds associated with the weakening Pacific front in Oklahoma, Texas, and southeastern New Mexico. Much of this cirrus was so thin that it is almost invisible in Figure 15. Figure 16 shows the sharp 300-mb trough and strong jet stream with winds of 170 kt over central Arizona and New Mexico, which supported these systems. Figures 17 and 18 show the soundings at El Paso, Texas, and Albuquerque, New Mexico on the morning of 2 February. The Pacific front shows up clearly on the El Paso sounding at the 5-km level. The advancing cirrus shows up on the Albuquerque sounding as a thin moist layer at 7.5 km. During the day, the polar front became stationary while the Pacific front regenerated over eastern Texas. By 0000Z on 3 February, the polar front showed signs of weakening, but the cirrus over central New Mexico remained there through 1200Z. Thus a continuous, persistent shield of thin cirrus was present throughout the time of the third sampling flight. The synoptic situation on this flight was strikingly similar to that of an earlier flight,[5] but on 2 February the upper air winds were somewhat stronger and the polar front somewhat weaker than on the earlier flight. Thus the resulting cirriform clouds seen on the previous occasion were more diffuse.

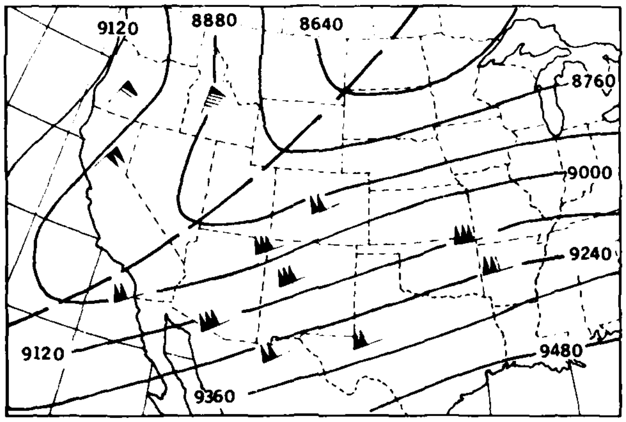


Figure 16. 300-mb Analysis at 0000Z, 3 February 1979. Heights shown in geopotential meters

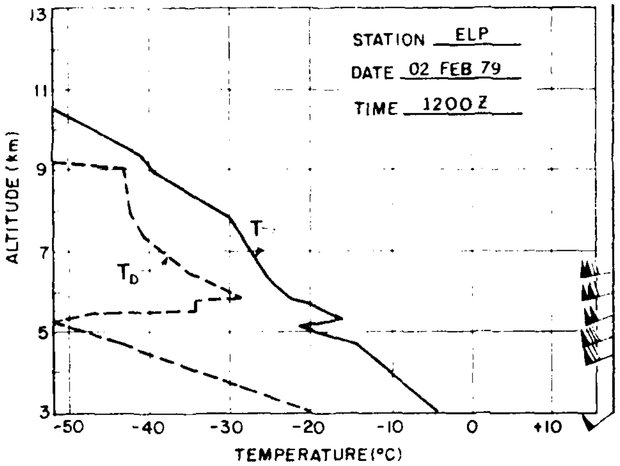


Figure 17. El Paso, Texas Sounding At 1200Z on 2 February 1979 Sampling Flight. Tropopause was at 11.8 km MSL. Winds were not measured above 6.6 km

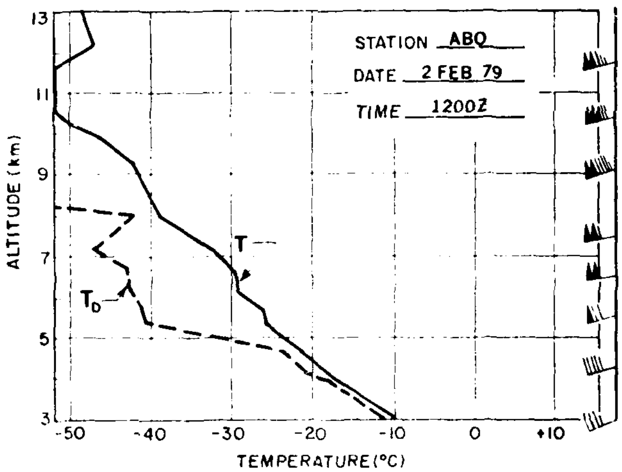


Figure 18. Albuquerque, N. M. Sounding At 1200Z on 2 February 1979 Sampling Flight. Tropopause was at 11.0 km MSL. Maximum wind was 181 kt at 10.5 km

4. 28 JANUARY 1979 FLIGHT AND DATA

The 28 January cirrus sampling began at Kirtland AFB, New Mexico, at 1924Z (1224 MST) and proceeded south, and then east. Most of the cirrus data were obtained over western Texas at altitudes between 7.5 and 9.5 km. The general flight track is shown in Figure 19.

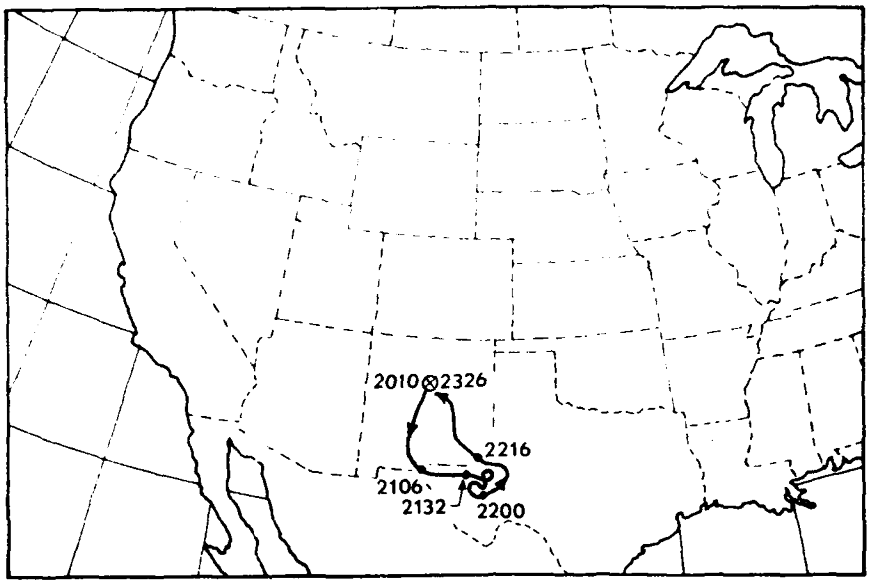


Figure 19. Path of C-130 Sampling Flight on 28 January 1979. Aircraft departed and landed at Kirtland AFB, Albuquerque, N. M. Numbers indicate times in UMT

4.1 Data Variations During the Flight

An over-all view of the variation of several parameters during part of the 28 January flight is shown in Figure 20. The top portion, for example, indicates, that the greatest altitude attained was near 9 km at about 2155Z. Outside air temperature during most of the flight at cirrus altitudes was between -30 and -36°C.

Part b of Figure 20 reflects mass determinations from the scatter probe (measuring particles from ~2 to 27 μm), whereas Part c shows similar values for the combined cloud and precipitation probes (ranges of ~26 to 4700 μm).

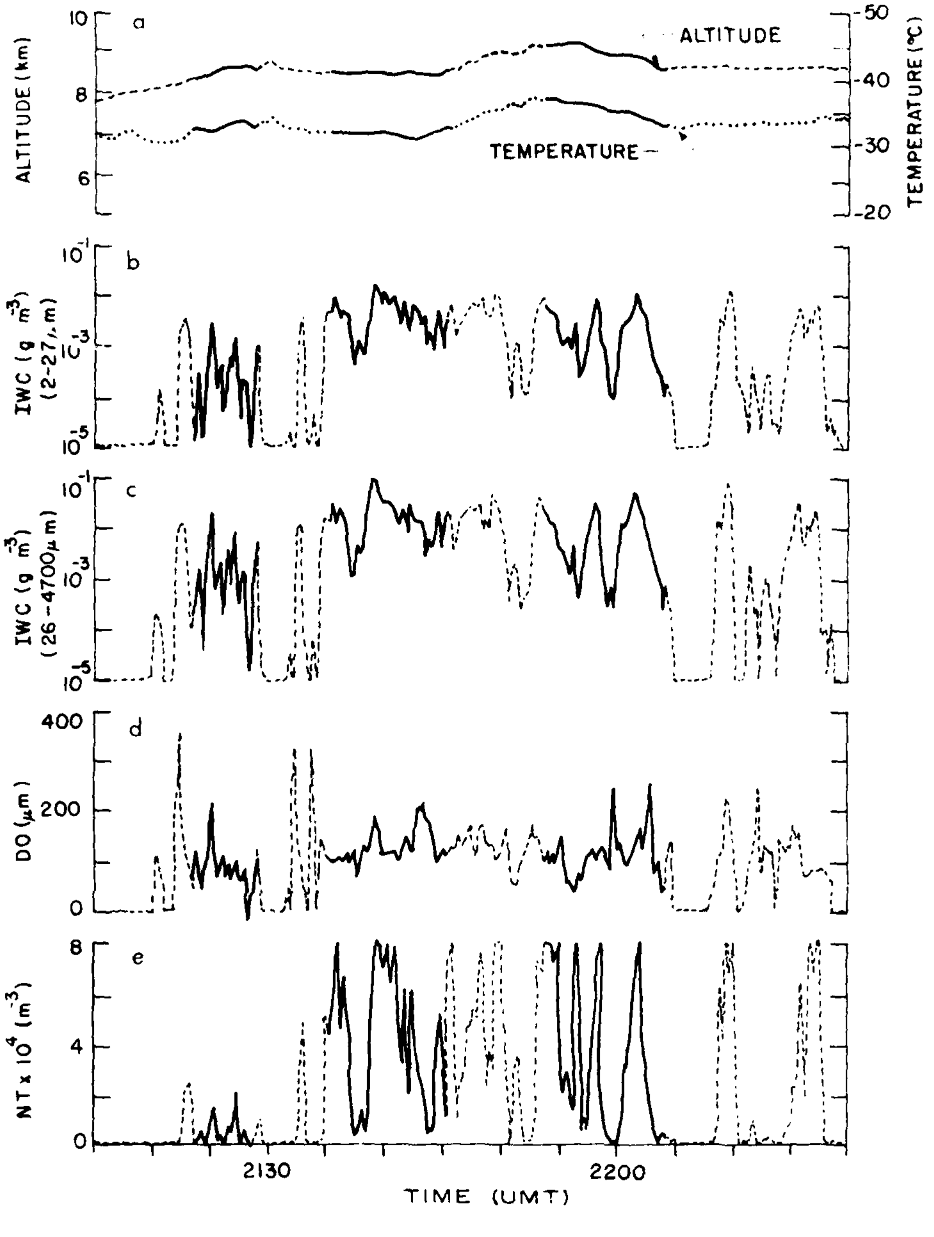


Figure 20. Variation With Time During 28 January Flight of (a) Aircraft Altitude and Temperature, (b) Ice Water Content from ASSP, (c) Ice Water Content from 1-D PMS Cloud and Precipitation Probes, (d) Median Volume Diameter of "Melted" Particles, and (e) Total Number of Particles Over 47-4700 μm Range. Based on values of consecutive 15 sec samples. Solid lines indicate data of the 3 passes described in Table 1

Variations of mass, as calculated from the two sets of probes, are well correlated, although absolute values are different, as should be expected. The problems of determining the mass of ice crystal regimes through use of a scatter probe have been recognized for some time. Both Hobbs et al[14] and Ryder[15] have cautioned that the Axial Scattering Spectrometer Probe (ASSP) produces an overestimate of ice crystal concentration because of multiple pulsing from the many faceted scattering particles. Despite this problem concerning data from the ASSP, measurements have been included on Figure 20 and other data formats herein, in order to provide at least a relative record of the small-sized ice crystals present.

For the 28 January sampling, Part c of Figure 20 shows that the greatest calculated IWC for a 15-sec sample was nearly 0.09 g m^{-3}, occurring at ~2139Z. The second highest value of about 0.08 g m^{-3} was determined for data at 2210Z.

The variation during the flight of the particle median volume diameter, D_o, a calculated quantity based on particles in the 26 to 4700 μm-size range, is shown in Part d of Figure 20. The D_o is the "equivalent melted" particle diameter at the fiftieth percentile of the ice water content; that is, half of the ice water exists in smaller melted droplet sizes, and half in larger sizes. Typical D_o values during most of the cirrus sampling on this flight were between 75 and 200 μm.

The variation of NT, the total number of particles in the 47- to 4700-μm range, is given in part f of Figure 20. This quantity varied considerably from very high to very low values as the aircraft passed through portions of heavier cirrus. Occasionally, values in excess of the 60, 000 m^{-3} upper limit of the figure were recorded. The greatest 15-sec NT was 142, 000 m^{-3}, which occurred at 2153Z. Three other consecutive samples were greater than 120, 000 m^{-3} at about 2139Z.

A more comprehensive tabulation of the values on Figure 20 for each 15 sec sample is given in Appendix A. In addition, Appendix A lists L_{max}, which is the mean physical size (in micrometers) of the largest spectrometer channel having ~1 particle m^{-3} mm^{-1}. For many purposes, this can be considered the largest particle size contributing to a given number-size spectrum. The L_{max} column in Appendix A shows the largest particles measured in most spectra, ranging from approximately 300 to 1300 μm. Values of less than 1000 μm are usually indicative of a spectrum made up of a small number of small particles, and may be discounted ordinarily, except as an indicator of subvisible cloudiness.

14. Hobbs, P.V., Radke, L.F., and Atkinson, D.G. (1975) Airborne Measurements and Observations in Cirrus Clouds, AFCRL-TR-75-0249, AD A015 037, 117 pp.

15. Ryder, P. (1976) The measurement of cloud droplet spectra. Preprints of Intnatl. Conf. on Cloud Phys., Boulder, Colorado, Amer. Meteor. Soc., 575-580.

The form factor of each 15-sec sample is also given in Appendix A under the "FF" heading. The form factor is a mathematical value between 0. and 1.00, first described by Plank[16] and Plank and Barnes.[17] It has been found useful in characterizing the shape of given spectra.

The form factor is calculated as

$$FF = \frac{\sum_{i=1}^{i=n} (2i-1)^3 \sigma_i}{\left[\sum_{i=1}^{i=n} (2i-1)^6 \sigma_i\right]^{0.5}} ,$$

where i is the specific channel of data being considered (from 2 to 15 for the PMS cloud probe and from 1 to 15 for the precipitation probe) and σ_i is the ratio of the number of particles in channel i to the total number in all channels (for sizes from -47 to 4700 μm).

Values of FF based on approximately 10 or fewer channels of particle data may be spurious and not meaningful. This is usually the case when FF is computed to be greater than 1.00 as often happens in the Appendices to this report. Plank[18] has also warned that the form factor can be ambiguous in that two different spectra may have the same FF number. However, in a previous AFGL report,[19] there was little difficulty in gaining useful intelligence from the form factor as long as the air temperature or altitude of a given sample was known. Figure 21, from that AFGL report, was developed from a study of particle spectra in both cirrus and lower clouds and shows the approximate FF values for four generalized spectra. The nearly straightline (on log-linear plots) exponential distributions are closely approximated by the factors in the 0.25 to 0.35 range.

The tabulations of data in the Appendices also include notes or comments made by the mission director during the course of the flights. He sat in the

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16. Plank, V.G. (1977) Hydrometeor Data and Analytical-Theoretical Investigations Pertaining to the SAMS Rain Erosion Program of the 1972-73 Season at Wallops Island, Virginia, AFGL-TR-77-0149, Environmental Research Papers 603, AD A051 192, 239 pp.

17. Plank, V.G., and Barnes, A.A., Jr. (1978) An improvement in obtaining real-time water content values from radar reflectivity, Preprints of 18th Conf. Radar Meteor., Atlanta, Amer. Meteor. Soc., 426-431.

18. Plank, V.G. (1979) Private Correspondence.

19. Varley, D.J. (1980) Microphysical Properties Of a Large Scale Cloud System 1-3 March 1978, AFGL-TR-80-0002, Environmental Research Papers 690, AD A083 140, 100 pp.

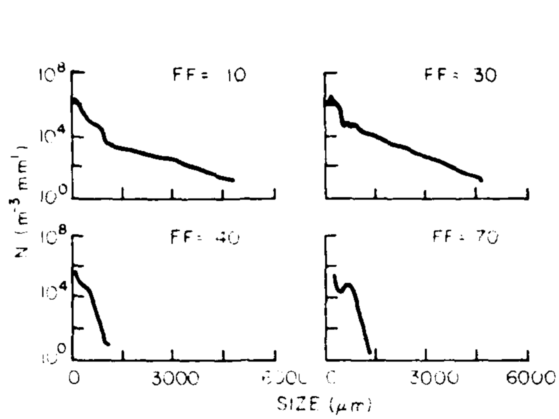


Figure 21. Typical Spectra and Representative Form Factor Values

aircraft cockpit and had a good vantage from which to see the type clouds being sampled.

4.2 Data for Particular Passes

After reviewing the mission director's notes, data tabulations, and the variation of data on Figure 20 we selected three periods during the flight for further studies. These are given in summary form in Table 1 and are also reflected on Figure 20 by the three intervals of solid lines across any given data plot. Brief order-of-magnitude (or larger) changes occurred in IWC and D_o during these periods, but generally cloud conditions were relatively homogeneous.

Table 1. Portions of 28 January 1979 Flight Examined in Figure 22

Pass	Period	Number of Samples	Average Temperature	Average Altitude (km)	Type
1	2123-2128Z	20	-33°C	8.5	Near Cs base
2	2135-2150Z	60	-33	8.6	In heavy Cs
3	2153-2203Z	40	-36	9.0	In heavy Cs

Data for five sets of variables for each of the three periods are shown in histogram form on Figure 22. The bottom row presents data for the 2123-2128Z period designated Pass 1, the middle row for 2135-2150Z Pass 2, and the top row for 2153-2203Z, Pass 3. The height of each histogram bar reflects the

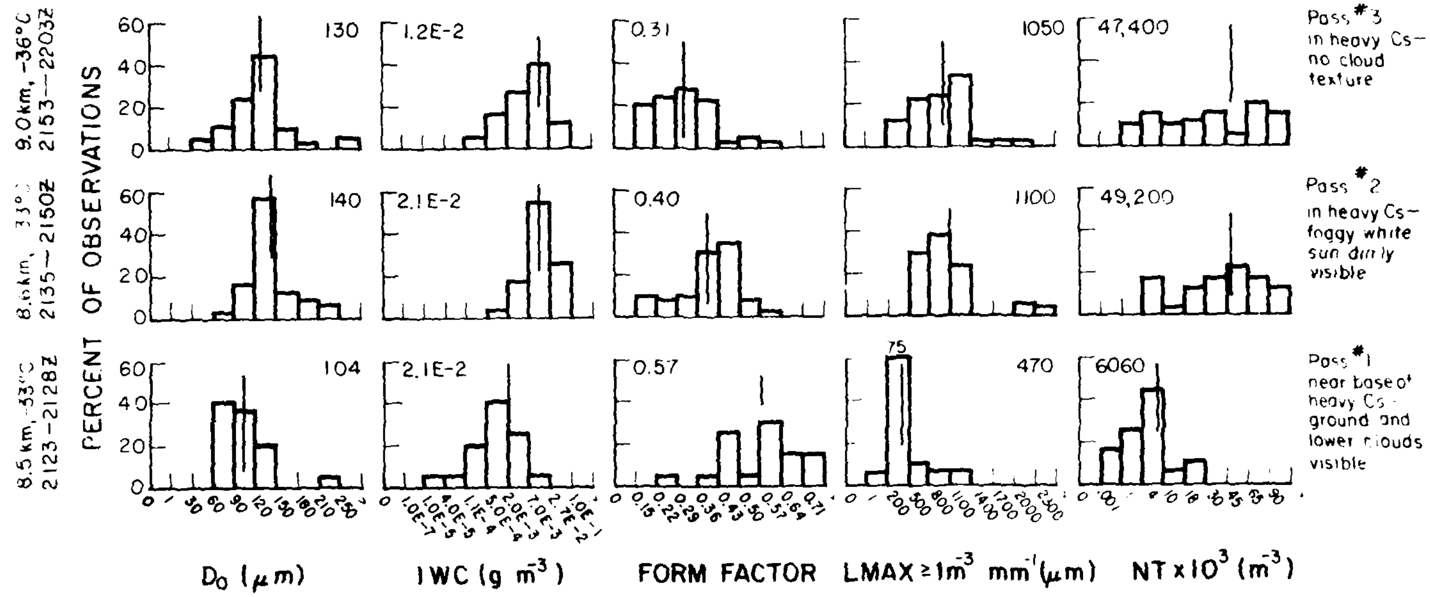


Figure 22. Percentage Frequency by Class of Five Measured or Calculated Variables. Based on total number of 15-sec mean values during 3 periods on 28 January 1979. Printed numbers and vertical lines are 50 percentile values. These do not consider data in cloud-free areas

percentage of sampling time that individual class values were measured or calculated. Each specific percentage was determined from the ratio of the number of 15-sec averages having a certain class value to the total number of 15-sec intervals in a sampling period, for example, the 5 min for the 2123-2128Z period had 20 samples.

The numerical value of the 50 percentile or median quantity of each variable is given with each Figure 22 histogram. A vertical line on each also gives the location of the mean along the abscissa scale. The mean value is based only on 15-sec samples when cloud data were being recorded. Intervals when the aircraft was outside all cloud, or was not recording ice particles are excluded in calculations of mean values, although these periods are reflected in a "no data" class at the extreme left in each histogram.

As an example of how Figure 22 may be read, it can be noted at the left side of the bottom row that the predominant (most frequently observed) D_o class was that having limits of 60 and 90 μm. It occurred in 40 percent of the 15 sec averages during the 2123 to 2128Z period. The mean value of D_o, however, was 104 μm. The location of the mean is indicated by a vertical line.

During the 2135 to 2150Z sampling period, the extreme left plot of the middle row of Figure 22 shows that nearly 60 percent of all D_o values were in the 120 to 150 μm class, and that the mean of 140 μm was also within those limits. The modal D_o class for Pass 3 was also that bounded by 120 and 150 μm, while the mean was 130 μm.

The five histograms of Pass 1 on the bottom row of Figure 22 are the result of a flight near or below the base of the visible portion of a heavy cirrostratus layer. The Pass 2 and 3 histograms show modal and mean values of various parameters in a heavier, more dense portion of the Cs. The IWC values in the latter two samples are nearly an order of magnitude greater than those acquired near the cloud base. Values of L_{max}, the largest particles recorded, were generally less than 500 μm in Pass 1, but were as large as 1100 μm during at least 20 percent of the sampling in heavy Cs. Another difference between Pass 1 and the other two was the larger mean number of particles, 47,000-49,000 m^{-3}, recorded in the middle of the Cs layer as opposed to a mean value of about 6,000 m^{-3} at the base of it. These passes were not above one another but were consecutive along the flight path as may be seen in Figure 19.

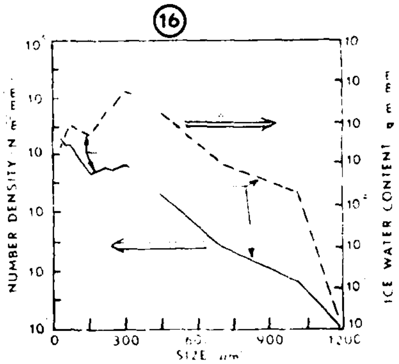
Spectra representing typical cloud conditions during the three 28 January sampling periods will be presented on ensuing pages in the format shown in Figure 23. This format is similar to those given in previous parts of this series with certain additional information being added and explained in the figure.

One significant change in the data format is the addition of two columns of data presenting information on the percentage of the total ice water content

(1) 28 JAN 79	(2) START TIME	(3) INTVL SEC	(4) TEMP C	(5) ALT KM	(6) IWC G/M**3	(7) IWC % CLD	(8) D0 MU	(9) NT N M**3	(10) FF	(11) PART TYPE
	21:22:45	15	-31.8	8.3	.0108	55	136	13836	.41	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

(12) SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	(15) PERCENT IWC/MM
(13) 2	1.32E+7	26	4.35E+5	1	437	5.20E+3	6
3	2.96E+	47	[illegible]	2	706	6.28E+1	<1
5	4.98E+7	67	2.52E+5	3	1011	4.64E+0	<1
7	1.02E+8	87	1.23E+5	3	1316	0.	0
9	1.04E+8	108	7.27E+4	2	1622	0.	0
11	9.98E+7	128	4.56E+4	2	1927	0.	0
12	9.66E+7	148	2.54E+4	2	2233	0.	0
14	6.63E+7	169	3.15E+4	3	2538	0.	0
16	6.63E+7	189	3.78E+4	4	2843	0.	0
18	5.46E+7	209	4.54E+4	6	3149	0.	0
19	5.06E+7	230	3.85E+4	7	3454	0.	0
21	5.37E+7	250	4.29E+4	9	3760	0.	0
23	2.96E+7	271	4.96E+4	14	4065	0.	0
25	3.51E+7	291	5.73E+4	20	4370	0.	0
27	2.42E+7	311	4.10E+4	17	4676	0.	0
(14) IWC	3.43E-3		5.99E-3			4.79E-3	



1. Date of sampling.
2. Beginning time of sample (Z time)
3. Sampling interval or duration in seconds over which data were averaged.
4. Average ambient temperature in $^{\circ}$C during sample.
5. Average pressure altitude in km MSL of sample
6. Ice water content in g m^{-3} calculated from particles of ~26 - 4700 μm size.
7. Percent of IWC in 6. determined from cloud probe (26 to 311 μm) data.
8. Mediam diameter of "melted" particles (in μm).
9. Total number of particles m^{-3} in the ~47 to 4700 μm size range.
10. Form factor (see text).
11. *Main recognizable particle type:* Bullet rosettes.
12. Nominal particle sizes measured by each channel of the scatter (ASSP), cloud, and precipitation probes.
13. Number of particles m^{-3} mm^{-1} in various size classes.
14. Ice water content (g m^{-3}) calculated from data of each probe.
15. Percent of 6 above per mm sampling width (see text).
16. Particle number-size distribution in solid lines; ice water content shown in dashed lines.

Figure 23. Description of Data Format

(measured over the 26 to 4700-μm size range and indicated by [15] in Figure 23) that is contributed by each channel of the 1-D cloud and precipitation probes. Because these probes have different size measuring channels, it was necessary to normalize the IWC data to a common millimeter width just as the particle number distribution data have been done. This permits a direct comparison of data between the two probes as if they measured over the same channel widths.

Figure 23 shows that 3 channels of the precipitation probe centered at 437, 706 and 1011 μm contributed less than 8 percent of the total IWC (on a normalized channel size basis). However, because these three channels have a larger measuring area than the cloud probe channels they were actually responsible for 4.79×10^{-3} g m^{-3} (shown at bottom of "Precip Probe" column) of the actual total.

Whether the normalized or unnormalized values of IWC are more valuable will depend on the ultimate use of the data.

Particle spectra and other data from the 3 passes described in the Figure 8 histograms are shown in Figures 24, 25 and 26. They indicate averages of conditions over selected 15 second intervals within the overall 5 to 15 minute passes. The particular interval was chosen for display from the many given in Appendix A to show most of the characteristics indicated by the modal classes in Figure 22. Emphasis was placed more on the predominant classes than mean values for the overall sampling period because it was found that in some instances the mean values rarely occurred. For example, the L_{max} of the spectrum (not shown here) incorporating all the data of Pass 1 was near 1000 μm, while the pass data on Figure 22 showed that 60 percent of the samples during the 5 min Pass 1 period had values less than 500 μm, and the mean of the several samples was 470 μm. The average spectrum for the entire pass in this case reflected the presence of an anomalously large number of particles in some size ranges that were not recorded in most individual 15-sec samples.

Figure 24 presents representative tabulated and plotted data during Pass 1 when the aircraft was moving in and out of portions of the base of a Cs layer. The greatest particle size recorded was in the 437-μm channel of the precipitation probe. The most significant contribution to overall ice water content was from the five largest channels of the cloud probe each of which provided 12 to 13 percent of the total.

28 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	21:24:30	15	-32.0	8.4	.0011	99	107	4536	.60	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	1.59E+6	26	1.48E+5	2	437	1.42E+0	<1
3	1.59E+6	47	7.80E+4	3	706	0.	0
5	4.77E+6	67	1.83E+4	1	1011	0.	0
7	6.35E+6	87	1.64E+4	2	1316	0.	0
9	8.73E+6	108	7.39E+3	1	1622	0.	0
11	9.53E+6	128	1.37E+4	4	1927	0.	0
12	4.76E+6	148	1.94E+4	7	2233	0.	0
14	3.97E+6	169	1.24E+4	6	2538	0.	0
16	3.18E+6	189	9.61E+3	6	2843	0.	0
18	3.97E+6	209	6.29E+3	5	3149	0.	0
19	7.15E+6	230	1.15E+4	12	3454	0.	0
21	4.77E+6	250	1.03E+4	13	3760	0.	0
23	7.95E+5	271	8.09E+3	13	4065	0.	0
25	7.93E+5	291	6.36E+3	13	4370	0.	0
27	3.17E+6	311	5.01E+3	12	4676	0.	0
IWC	2.56E-4		[illegible].09E-3			[illegible]	

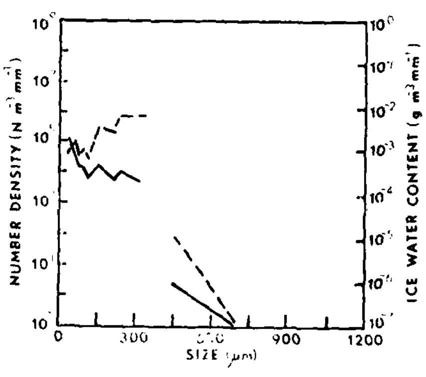


Figure 24. Representative Ice Crystal Spectrum for a 15-sec Interval During Pass 1 Through the Base of a Cirrostratus Layer on 28 January 1979

28 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	21:41:30	15	-31.7	8.4	.0230	53	138	58455	.39	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	2.02E+7	26	9.78E+5	1	437	1.17E+4	7
3	5.84E+7	47	9.93E+5	3	706	1.52E+2	1
5	8.76E+7	67	5.43E+5	3	1011	3.35E+0	<1
7	2.37E+8	87	2.62E+5	3	1316	0.	0
9	2.48E+8	108	1.81E+5	3	1622	0.	0
11	1.86E+8	128	7.50E+4	2	1927	0.	0
12	1.70E+8	148	6.12E+4	2	2233	0.	0
14	1.38E+8	169	3.53E+4	1	2538	0.	0
16	1.44E+8	189	5.09E+4	2	2843	0.	0
18	1.06E+8	209	5.94E+4	4	3149	0.	0
19	9.65E+7	230	6.10E+4	5	3454	0.	0
21	9.44E+7	250	9.20E+4	10	3760	0.	0
23	7.79E+7	271	1.07E+5	15	4065	0.	0
25	4.94E+7	291	1.25E+5	21	4370	0.	0
27	2.92E+7	311	8.97E+4	18	4676	0.	0
IWC	6.27E-3		1.22E-2			1.08E-2	

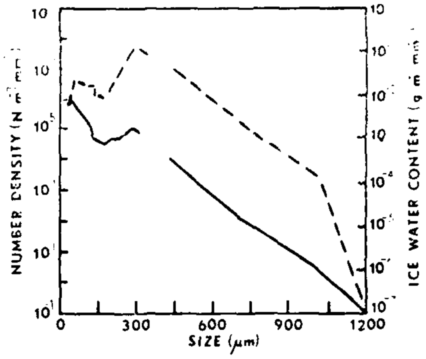


Figure 25. Representative Spectrum for a 15-sec Interval During Pass 2 Through Heavy Cs on 28 January 1979

28 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	22:01:15	15	-35.2	8.9	0212	54	136	62368	.32	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	1.18E+7	26	8.26E+5	1	437	9.62E+3	6
3	2.43E+7	47	9.79E+5	3	706	2.66E+2	1
5	4.28E+7	67	4.33E+5	3	1011	1.65E+1	<1
7	1.09E+8	87	3.04E+5	3	1316	1.16E+0	1
9	1.37E+8	108	2.14E+5	4	1622	0.	0
11	1.15E+8	128	1.63E+5	4	1927	0.	0
12	8.64E+7	148	1.59E+5	5	2233	0.	0
14	8.34E+7	169	9.94E+4	4	2538	0.	0
16	7.60E+7	189	1.14E+5	6	2843	0.	0
18	8.34E+7	209	1.13E+5	8	3149	0.	0
19	7.09E+7	230	9.65E+4	9	3454	0.	0
21	4.35E+7	250	8.11E+4	9	3760	0.	0
23	4.06E+7	271	7.42E+4	11	4065	0.	0
25	3.32E+7	291	6.78E+4	12	4370	0.	0
27	2.58E+7	311	5.17E+4	11	4676	0.	0
IWC	3.89E-3		1.14E-2			9.73E-3	

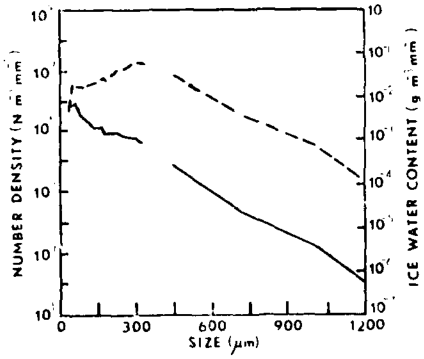


Figure 26. Representative Spectrum for a 15-sec Interval During Pass 3 Through Heavy Cs on 28 January 1979

The spectrum in Figure 25, representing the middle of a fairly heavy cirrostratus layer, exhibits a minimum in the distribution curve near the 170 μm particle size while there is a maximum in the curve at approximately 290 μm. Similar minima were observed in cirriform spectra described by Varley.[19] They have also been pointed out by Heymsfield[9] as being somewhat typical in cirrus uncinus heads. He thought the maximum at sizes near or below 500 μm might reflect an accumulation of crystals of that length in an updraft. Some 21 percent of the total Figure 25 IWC was due to particles recorded by the 291-μm channel size.

The distribution of Figure 26, in heavy fog-like Cs, has a nearly straight-line, exponential decrease of particle number with increasing size. As in the previous figure, the greatest contribution to over-all ice water mass was at the 291-μm channel size; but the IWC curve in Figure 26 is considerably smoother than those shown in Figures 24 and 25. The form factor of the Figure 26 spectrum is 0.32, which is in the 0.25 to 0.35 range previously identified and associated with exponential distributions.

Both Figures 25 and 26 spectra are from heavy cirrostratus clouds. While minimum and maximum points are evident at sizes less than 500 μm in the former, they are absent in the latter. Such valley-peak distributions may be evidence of an aggregation mechanism which occurs more frequently in the middle and lower portions of Cs. The Figure 26 spectrum represents data from an altitude of 8.9 km MSL, perhaps above the level that aggregation begins. At 8.4 km, the altitude of the Figure 25 spectrum, the aggregation process may have been better established.

5. 29 JANUARY 1979 FLIGHT AND DATA

The 29 January flight departed Kirtland AFB at 1647Z (0947 MST) and flew north and east into the Pueblo, Colorado area. Several sampling passes were made at lower levels east of the Rocky Mountains for another AFGL program, then sampling in the thin cirriform clouds above the surface storm began at about 1845Z. As the aircraft proceeded in a generally southerly direction back to Kirtland, the cloud tops decreased in height. The main portions of this day's flight track were as indicated on Figure 27.

5.1 Data Variations During the Flight

The variations of several measured or calculated variables during the 29 January sampling are plotted on Figure 28. Since the flight was made near the upper level low, the outside air temperature and cirrus tops were both lower

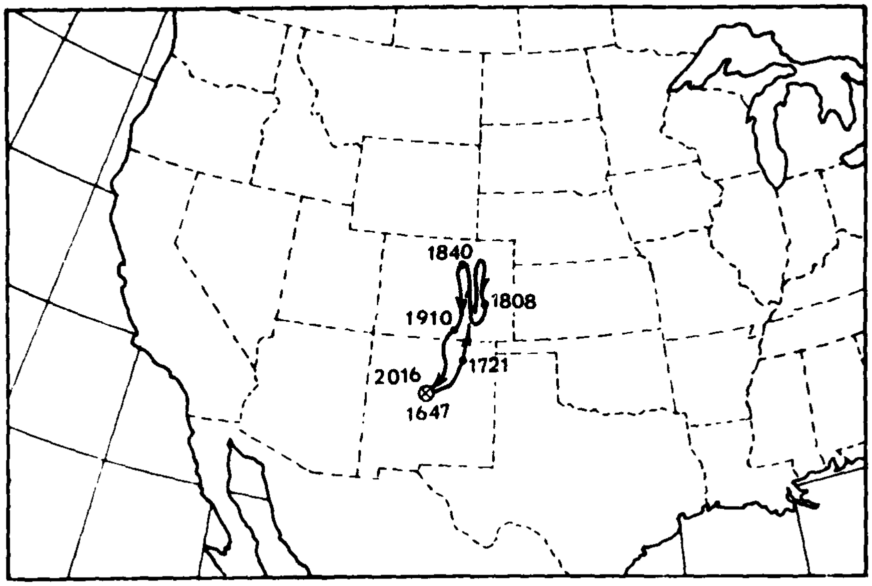


Figure 27. Flight Track of Sampling Aircraft on 29 January 1979. Numbers indicate times in UMT

than those observed in most previous flights. As shown in the top of Figure 28, all sampling was accomplished at altitudes less than 8 km (26,000 ft) MSL. As the aircraft moved southward, the cirriform tops were found at progressively lower altitudes.

By 1945Z the C-130 was in the thin cloud tops over northern New Mexico at slightly above 5 km. There was some doubt at that time whether those clouds could be considered cirriform; however, they were definitely composed of ice particles and the temperature was -30°C or colder, which Mason,[20] among others, has indicated satisfies the criteria to be considered cirriform.

Parts (b) and (c) of Figure 28 show that the variations of IWC as determined from measurements of the scatter probe and the cloud plus precipitation probes were fairly well correlated. There was one extended period, however, beginning about 1905Z when the scatter probe recorded a small number of small particles when there were no measurements in the other probes. The largest calculated IWC of this sampling over the 26 to 4700 μm range was 0.06 g m^{-3} at about 1848Z. The radical high to low IWC changes occurring between 1920 and 1940Z are indicative of passage through numerous small cloud elements.

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20. Mason, B.J. (1962) Clouds, Rain and Rainmaking, Cambridge University Press, 145 pp.

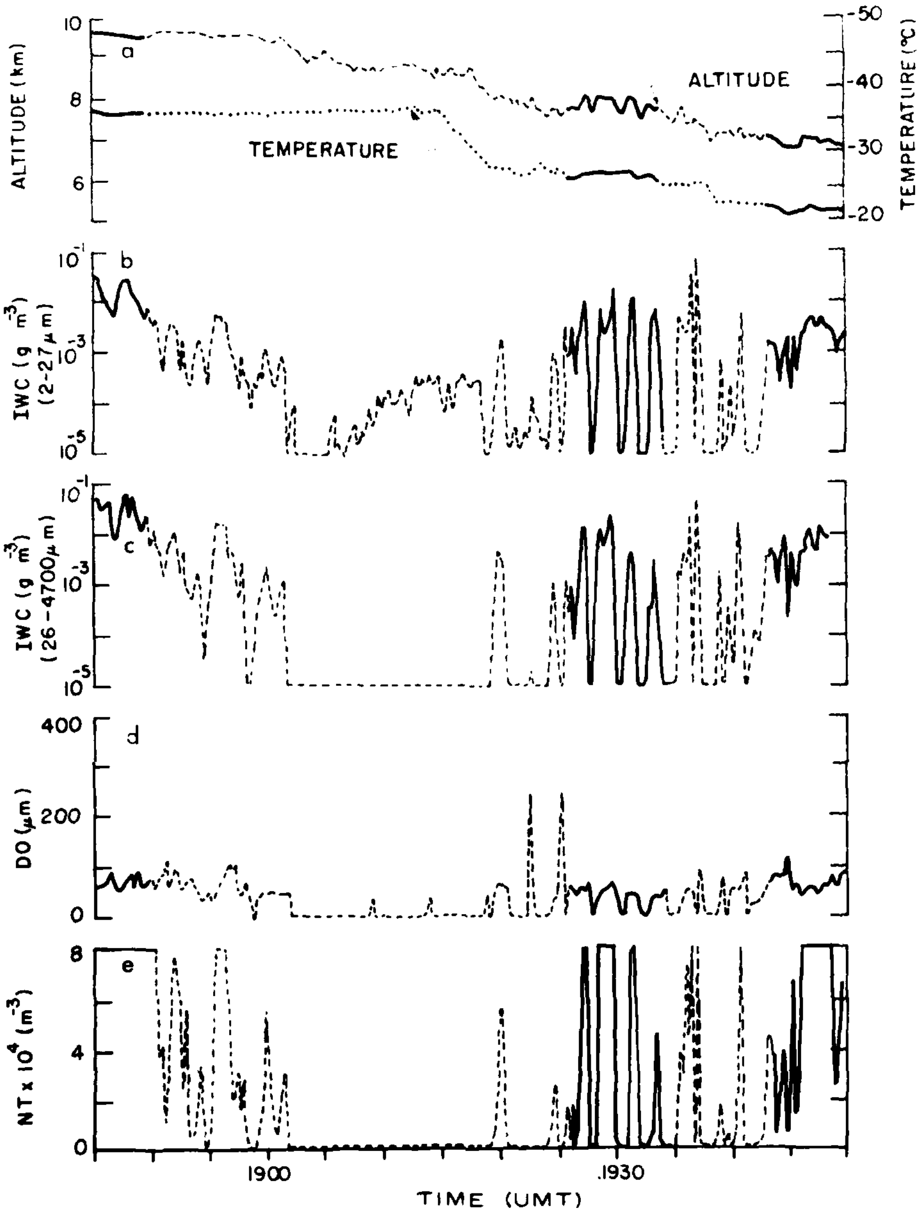


Figure 28. Variation With Time During 29 January 1979 Flight of (a) Aircraft Altitude and Temperature, (b) Ice Water Content from ASSP, (c) Ice Water Content from 1-D PMS Cloud and Precipitation Probes, (d) Median Volume Diameter of "Melted" Particles, (e) Total Number of Particles Over 47-4700 μm Range. Based on values of consecutive 15-sec samples. Solid lines indicate data of the 3 passes described in Table 2

The median volume diameter of typical "melted" particles was quite small in this sampling. Values ranged from approximately 30 to 125 μm, with only a few higher than 150 μm. The variation of D_0 during the flight is shown in Part (d) of Figure 28.

The total numbers of particles detected during most of the cloud penetrations on 29 January were high with respect to our previous experience. During the 1845 to 1850Z period, for example, the average number was 358,000 m^{-3}. This compares to an average of 25,000 m^{-3} measured during a 9.0 km pass through thin cirrus over New Mexico on 1 March 1978 (Varley)[19] and a mean of 49,000 m^{-3} recorded during one pass in this report on 28 January 1979. The many changes of NT on Figure 28, Part (e) are again a reflection of the numerous entries into, and departures from, small cirriform cloud elements.

The Figures 29 and 30 photographs show the general type of cloud conditions sampled on 29 January. Figure 29 might be considered a "close up" view of the very thin cirrus filaments that fade with height above the main cloud mass into blue sky. Figure 30 shows the main layer of cirrostratus from a distance. An area of snow-covered ground is in the bottom left. The flight proceeded toward the very top of the clouds shown in Figure 30.

5.2 Data for Particular Passes

Three extended periods during the 29 January sampling were selected for further examination and given in Table 2. These were chosen because cloud conditions were fairly homogeneous; however, a few large changes in the microphysical variables did occur. In fact, during Pass 5 nearly 30 percent of the time the aircraft was above or between measurable cloud particles. Pass numbers were selected to be continuous from one day to the next, that is, "Pass 4" is the fourth pass considered in this report.

Table 2. Portions of 29 January 1979 Flight Examined in Figure 31

Pass	Period	Number of Samples	Average Temperature	Average Altitude (km)	Type
4	1845-1850Z	20	-48°C	7.7	In Cs near tops
5	1926-1934Z	32	-37	6.1	Skim. Cs/Cc tops
6	1943-1950Z	28	-31	5.2	Skim. Cs/Cc tops

Figure 29. Photo of Thin Cirrus Sampled Above Main Cs Cloud, 29 January at 1906Z. Dark blue sky at top. Near 37°47'N, 104°50'W

Figure 30. Photo of Main Cs Cloud 29 January at 1951Z. Sampling Proceeded Through Extreme Top of Cs Shown. Near 35°28'N, 105°29'W. Dark blue sky at top. Area of snow-covered ground at bottom left

During Pass 4, sampling took place in relatively dense [illegible] the tops. A halo often appeared around the sun, since the [illegible] obscured by the higher portion of the Cs. There was [illegible] [illegible] above, and blue sky could occasionally be seen. [illegible] the period, the Cs had thinned considerably and much [illegible] seen through very thin cirrus filaments above.

Sampling during both Pass 5 and Pass 6 was in the [illegible] above the [illegible] Cs and Cc. Occasionally one of the higher [illegible] above the bulk of lower clouds was penetrated. These consisted of [illegible] filaments which resembled fog overlaying a body of water [illegible]. The tops of these filaments faded into the blue sky at or slightly above the sampling altitude.

Of the three passes the largest values of IWC were calculated for particles during Pass 4, as shown on Figure 31. The average IWC was [illegible] $\times 10^{-2}$ g [illegible] for Pass 4 and nearly an order of magnitude less for the other two passes.

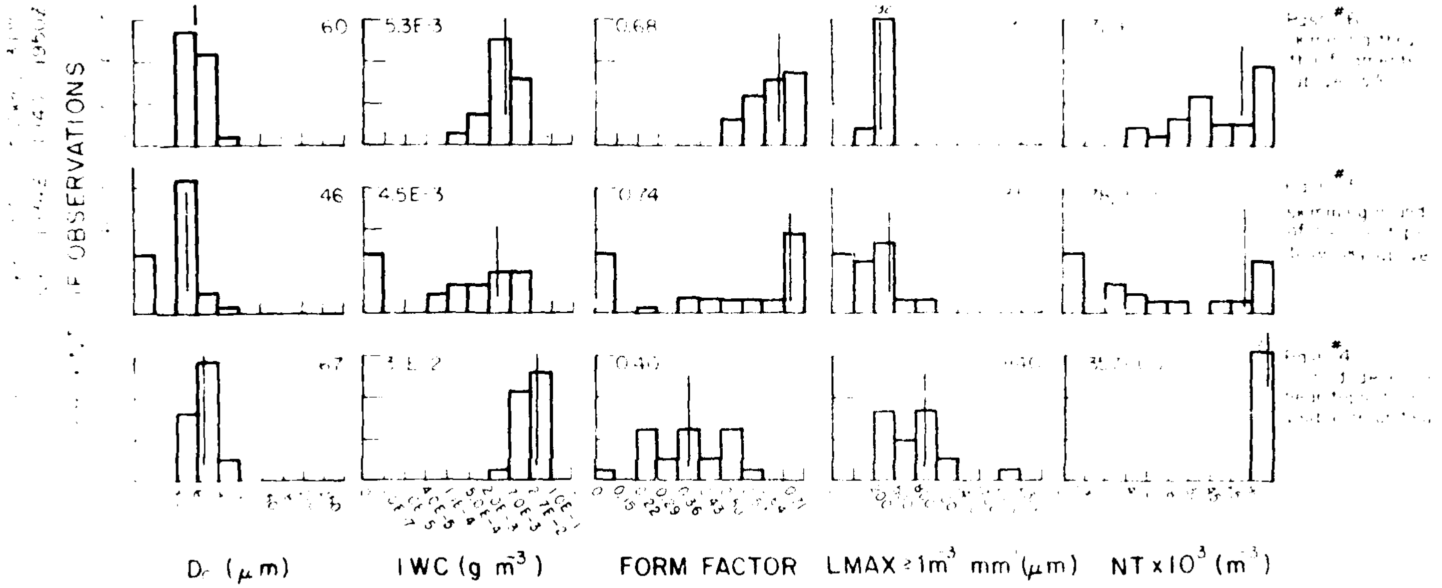
As previously *indicated, there* was an extraordinarily high number of particles recorded in the Pass 4 Cs—more than 350,000 m^{-3}. The NT number class above 90,000 m^{-3} was also the predominant one having most individual samples during the other passes, although the average figures in these cases were not as great—78,000 and 73,000 m^{-3}.

The L_{max} histograms on Figure 31 show that the largest particles were recorded in Pass 4 going through Cs. About 15 percent of the particles were larger than 1100 μm and one 15 sec sample had an L_{max} exceeding 2000 μm. The predominant L_{max} class for both the Pass 5 and 6 data was that bounded by 200 and 500 μm.

The histograms showing median volume diameter, D_o, on Figure 31 indicate a generally small range of occurrence. Most values of D_o were less than 90 μm, though one during Pass 6 was as great as 108 μm. The averages of the three 29 January passes varied only from 46 through 67 μm.

The differences in predominant form factor classes between the 3 passes indicate there were differences in typical number-size spectra. Some 50 percent of the form factors of the Pass 4 were less than 0.40, while about 40 percent of those during Pass 5 were equal to or greater than 0.71. Some of the differences are evident in the representative spectra for each of the passes shown in the following figures.

Figure 32 shows a particle spectrum *representative of the predominant* conditions recorded during the 1845 to 1850Z pass period on 29 January. Both this and the Figure 26 spectra were recorded in the upper parts of a Cs layer and both approximate an exponential decrease of particle number with increasing size. The median volume diameter of the Figure 32 data, however, is 82 μm while [illegible]



Percentage Frequency by Class of Five Measured [illegible] Variables. [illegible] total number of [illegible] values during 3 periods on 29 January 1979. Pointed numbers and vertical lines are [illegible] percentile [illegible] do not consider data in cloud-free areas.

29 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	18:46:15	15	-4[illegible]	[illegible]	.0405	8[illegible]	8.[illegible]	310314	.38	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	3.[illegible]E+7	26	4.52E+6	[illegible]	437	[illegible].64E+3	[illegible]
3	5.32E+7	47	4.34E+6	5	706	3.[illegible]E+[illegible]	[illegible]
5	9.91E+7	67	3.01E+6	[illegible]	1011	4.8[illegible]E+0	[illegible]
7	1.59E+8	87	2.45E+6	9	1316	0.	0
9	2.15E+8	108	1.62E+6	9	1622	0.	0
11	2.06E+8	128	1.24E+6	10	1927	0.	0
12	2.05E+8	148	[illegible].37E+5	8	2233	0.	0
14	1.53E+8	169	4.76E+5	[illegible]	2538	0.	0
16	1.97E+8	189	3.71E+5	7	2843	0.	0
18	1.77E+8	209	3.09E+5	[illegible]	3149	0.	0
19	1.79E+8	230	2.13E+5	6	3454	0.	0
21	1.75E+8	250	1.56E+5	6	3760	0.	0
23	1.77E+8	271	1.15E+5	6	4065	0.	0
25	1.25E+8	291	8.52E+4	5	4370	0.	0
27	1.20E+8	311	5.84E+4	4	4676	0.	0
IWC	1.24E-2		3.55E-2			5.04E-3	

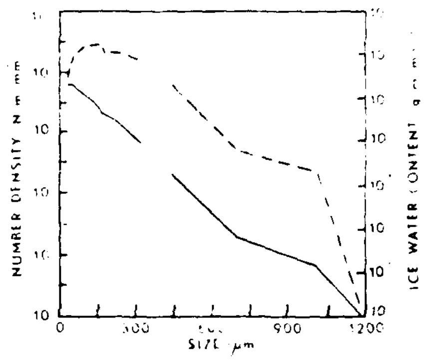


Figure 32. Representative Spectrum for a 15-sec Interval During Pass 4 Through Tops of Moderately Dense Cs on 29 January 1979

29 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	19:29:00	15	-38.0	6.2	.0049	100	51	85531	.75	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	9.04E+5	26	1.35E+6	4	437	0.	0
3	4.51E+6	47	1.44E+6	12	706	0.	0
5	9.04E+6	67	1.23E+6	20	1011	0.	0
7	1.36E+7	87	8.69E+5	24	1316	0.	0
9	2.18E+7	108	3.42E+5	15	1622	0.	0
11	2.44E+7	128	1.84E+5	11	1927	0.	0
12	2.81E+7	148	6.15E+4	5	2233	0.	0
14	3.27E+7	169	4.05E+4	4	2538	0.	0
16	3.17E+7	189	1.09E+4	1	2843	0.	0
18	1.99E+7	209	4.77E+3	1	3149	0.	0
19	2.53E+7	230	1.31E+4	3	3454	0.	0
21	3.26E+7	250	0.	0	3760	0.	0
23	3.17E+7	271	0.	0	4065	0.	0
25	2.81E+7	291	0.	0	4370	0.	0
27	2.35E+7	311	0.	0	4676	0.	0
IWC	2.15E-3		4.90E-3			0.	

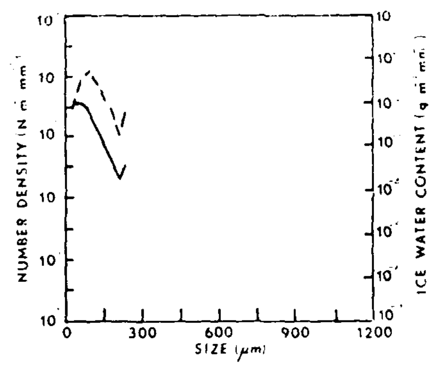


Figure 33. Representative Spectrum for a 15-sec Interval During Pass 5 While Skimming Cs/CC Tops on 29 January 1979

29 JAN 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FI	PART TYPE
	19:46:00	15	-31.0	5.2	.0035	100	44	91340	.70	BP

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	1.87E+6	26	2.67E+6	9	437	0.	0
3	1.57E+7	47	2.34E+6	24	706	0.	0
5	2.86E+7	67	1.31E+6	27	1011	0.	0
7	3.78E+7	87	5.90E+5	21	1316	0.	0
9	4.62E+7	108	1.60E+5	9	1622	0.	0
11	5.45E+7	128	4.80E+4	4	1927	0.	0
12	4.62E+7	148	2.02E+4	2	2233	0.	0
14	3.98E+7	169	6.32E+3	1	2538	0.	0
16	3.24E+7	189	1.12E+4	2	2843	0.	0
18	3.24E+7	209	2.49E+3	1	3149	0.	0
19	3.51E+7	230	0.	0	3454	0.	0
21	4.34E+7	250	0.	0	3760	0.	0
23	4.53E+7	271	5.57E+2	<1	4065	0.	0
25	3.51E+7	291	1.11E+3	1	4370	0.	0
27	2.13E+7	311	2.23E+3	2	4676	0.	0
IWC	2.78E-3		3.91E-3			0.	

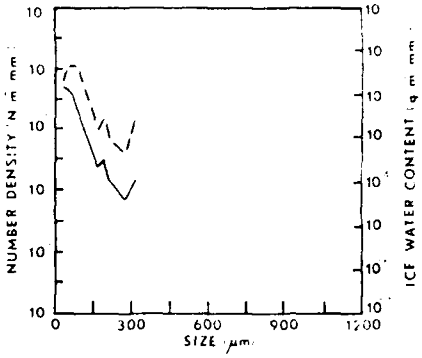


Figure 34. Representative Spectrum for a 15-sec Interval During Pass 6 Through Thin Filaments on Top of Cs/Cc Layer on 29 January 1979

for Figure 26 is 136 μm. Figures 33 and 34 show another difference between the two sets of data. The number density is about one-fourth of that detected lower in the Cs, but still a large figure in comparison to our other flight data. As mentioned above, these large NTs are probably associated with the proximity of the surface storm and the fact that particles were being generated profusely.

6. 2 FEBRUARY 1979 FLIGHT AND DATA

The cirriform clouds sampled on 2 February were primarily associated with a weak cold front and a band of strong winds aloft over the southwestern part of the United States. The aircraft recorded winds in excess of 150 kt. Most of the sampling was accomplished at altitudes between 9 and 10 km MSL over the eastern part of New Mexico as shown in Figure 35.

6.1 Data Variations During the Flight

As previously indicated, and as shown in the top part of Figure 36, most of the sampling on 2 February was conducted near the 9-km MSL level. Free air temperatures recorded by the C-130 were between -38 and -44°C.

The plots of Parts (b) and (c) on Figure 36 show that the variation of ice water mass determined from the scatter probe (in Part b) and the cloud and precipitation probes (in Part c) were generally well correlated. Several IWC values from

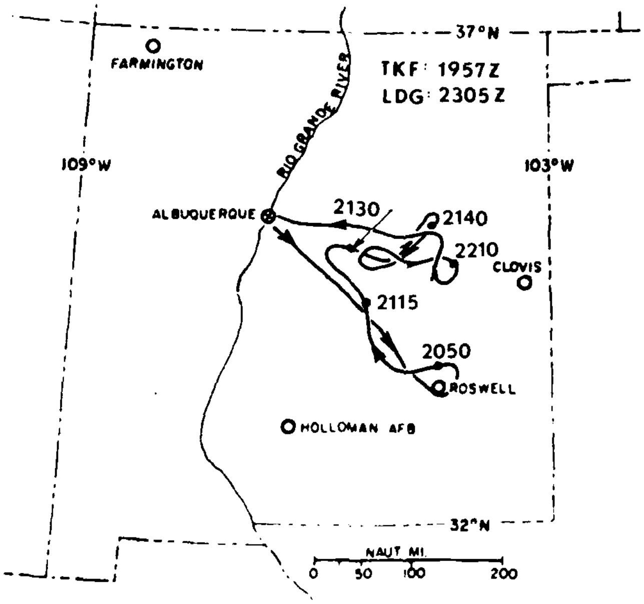


Figure 35. Flight Track of Sampling Aircraft on 2 February 1979. Numbers indicate times in GMT

the latter 2 probes reached as high as 0.005 g m^{-3}, while the peak values were *0.010 at 2108Z and 0.018 g m^{-3} at 2201Z. The relatively small amplitude swings* in the IWC plot on Figure 29 indicate the cirriform clouds sampled on 2 February were more consistent and uniform over a given area than those examined on the other two days.

The median volume diameter, D_o, of individual 15-sec samples was generally less than 100 μm during most of this flight. As shown in Part d of Figure 29, none were as large as 150 μm. There was more temporal variation in IWC value than in those of D_o, but this was to be anticipated since IWC varies with the third power of D_o.

There was extensive variation during the flight of the total number of particles detected in the 27 to 4700 μm range. Most values of NT were less than 60,000 m^{-3}, but there were two periods from 2107 to 2113Z and from 2201 to 2209Z when they were considerably greater. During the former period, the greatest single value was 156,000 m^{-3} at 2108:45Z, and during the latter period the maximum was 255,000 m^{-3} at 2201:15Z.

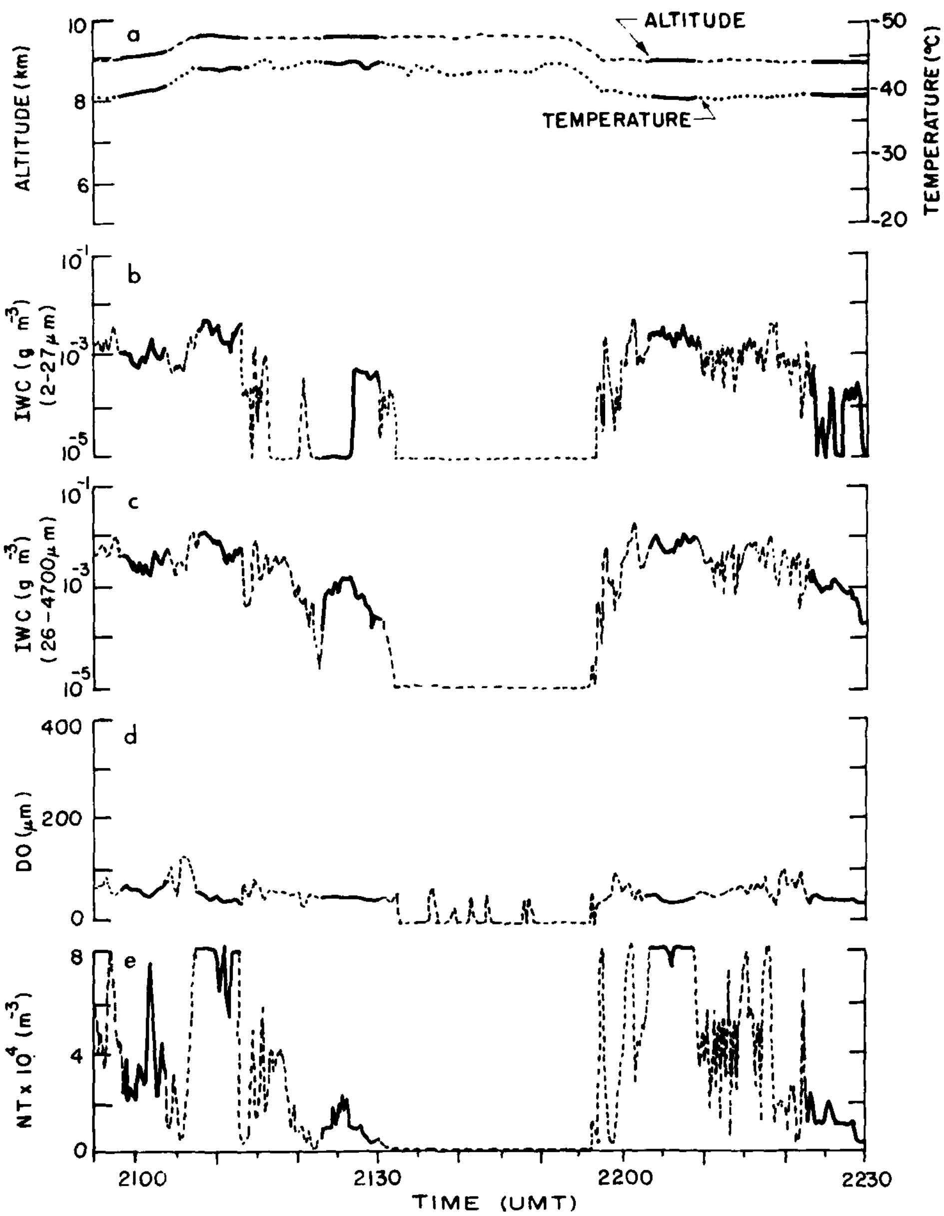


Figure 36. Variation With Time During 2 February 1979 Flight of (a) Aircraft Altitude and Temperature, (b) Ice Water Content from ASSP, (c) Ice Water Content from PMS Cloud, 1-D and Precipitation Probes, (d) Medium Volume Diameter of "Melted" Particles, (e) Total Number of Particles Over 47-4700 μm Range. Based on values of consecutive 15-sec samples. Solid lines indicate data of the 5 passes described in Table 3

6.2 Data for Particular Passes

Based on a review of the data variations on Figure 36 and of the tabulations in Appendix C, 5 periods of approximately 5 minutes or longer were selected for further examination. These were selected based on the relative homogeneity of th data. The period selected are as given in Table 3. The frequencies of particular class values within these periods are shown in the histograms of Figure 37.

Table 3. Portions of 2 February 1979 Flight Examined in Figure 37

Pass Number	Period	Number of Samples	Average Temperature	Average Altitude (km)	Type
7	2058-2104Z	26	-39°C	9.2	Moderate heavy Cs
8	2108-2113Z	21	-43	9.6	In tops of Cs
9	2123-2130Z	28	-44	9.6	Very thin Ci
10	2203-2209Z	24	-38	9.0	Heavy Cs
11	2223-2229Z	25	-39	8.9	Very thin Ci

During Pass 7 of this report (the first on 2 February), the aircraft was flying along and in a band of Cs of varying density. Most of the calculated values of ice water content were in the relatively narrow range of 2 to 7×10^{-3} g m^{-3} as shown on the bottom line of Figure 37. The 64 μm mean D_o value and the 340 μm mean L_{max} value are the largest of those in the 5 passes examined here. The mean NT of 34,000 m^{-3} is less than the corresponding values near 48,000 m^{-3} detected in somewhat similar clouds in Passes 2 and 3 taken on 28 January 1979.

The data of Pass 8 were acquired while flying within about 1000 ft of the top of the Cs band. The sky was quite blue above and the ground was dimly visible, but horizontal visibility was greatly reduced. The mean D_o of 50 μm was the smallest of the five 2 February passes, but the mean particle count, NT, of 106,000 m^{-3} was the largest.

Passes 9 and 11 were both made through very thin cirrus, and in both cases the mean number of particles detected was less than 13,000 m^{-3}, as indicated on Figure 37. Only Pass 1, when downward visibility was good, had a lower NT value. The greatest mean particle sizes, L_{MAX}, were 170 and 215 μm. These are the smallest of the 11 cases considered in this report. The calculated IWC values of 1×10^{-3} g m^{-3} or less are also the smallest ones in this report. While flying and acquiring data of Passes 9 and 11 the mission director noted that in the

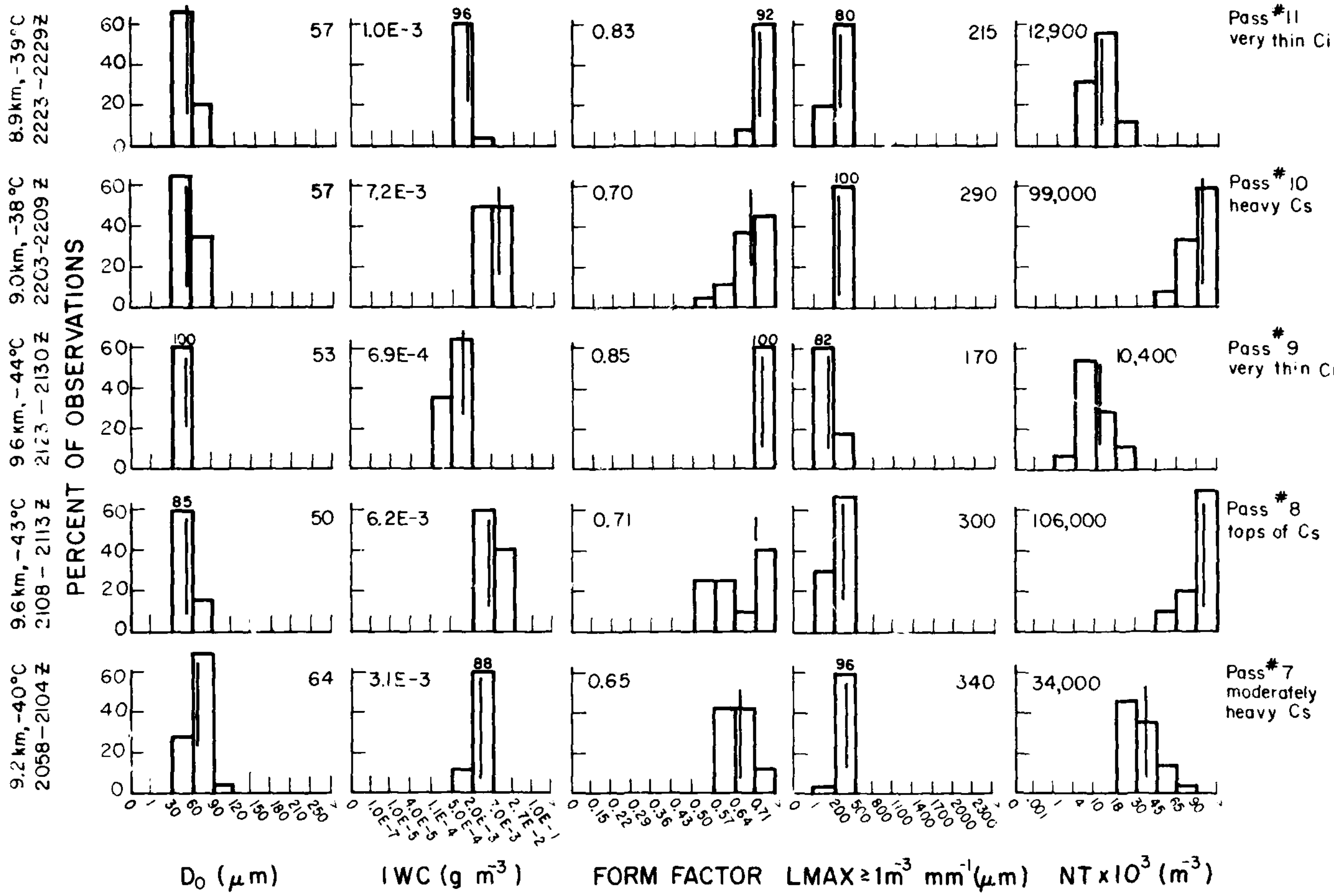


Figure 37. Percentage Frequency by Class of Five Measured or Calculated Variables. Based on total number of 15-sec mean values during 5 periods on 2 February 1979. Printed numbers and vertical lines are at 50 percentile values. These do not consider data in cloud-free areas

vicinity of the airplane there hardly seemed to be any cloud present at all. The data suggests that his observation might have been due to a lack of contrast with clouds all around.

The cloud sampled during Pass 10 was a relatively heavy cirrostratus that provided the highest mean IWC value of any of the five 2 February passes. The ground was only dimly visible and no blue sky could be seen, though the sun shone through the Cs. The number of particles detected in this case was 99,000 m^{-3}, only slightly less than that recorded during Pass 8.

Some representative particle data for the passes made on 2 February are given in the following figures. As in similar foregoing figures, the data have been averaged over a representative 15-sec segment of a particular pass period.

Data for the moderately heavy Cs samples on Pass 7 are shown in Figure 38. The largest particles detected were 437 μm in size, though there were very few of these. Particles in the 125 to 175 μm range made the greatest contribution to total calculated ice water content.

The spectrum given in Figure 39 has a maximum recorded particle size of 311 μm, although the total particle count, NT, is in excess of 88,000 m^{-3}. There is a smooth decrease of particle counts as size increases, but without particles larger than 400 μm, the form factor is a relatively high 0.70.

The greatest particle size recorded in the Figure 40 spectrum of very thin cirrus is 169 μm. The bulk of the total IWC was contributed by particle sizes between 67 and 108 μm. Since there are less than 10 channels of data in the cloud and precipitation probe ranges, the form factor computation is not necessarily meaningful. It does appear, however, that when few spectrometer channels have data, the form factor is quite high — above about 0.75.

There is considerable similarity between the spectra in Figures 39 and 41. In one case the NT is 88,000 and in the other 100,000 m^{-3}. In both instances, the largest recorded particles were near 311 μm, and in both the greatest contribution to IWC was made by particles in the approximate 50- to 125-μm range.

Both of the thin cirrus spectra shown in Figures 40 and 42 exhibit maximum sized particles near 200 μm or smaller. They also have a relatively small number of particle counts in the $\sim$47-4700-μm range, 8600 and 13,400 m^{-3}. Both also have high form factor values, though, as noted above these are based on a very small number of channels of data and hence are not very reliable.

02 FEB 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	20:50:45	15	-38.9	9.1	.0032	99	74	25403	.63	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	4.05E+6	26	0.	0	437	3.38E+0	<1
3	1.25E+7	47	2.03E+5	4	706	0.	0
5	1.14E+7	67	1.99E+5	5	1011	0.	0
7	3.95E+7	87	1.71E+5	7	1316	0.	0
9	3.07E+7	108	1.34E+5	9	1622	0.	0
11	2.70E+7	128	1.69E+5	16	1927	0.	0
12	2.29E+7	148	1.07E+5	13	2233	0.	0
14	1.89E+7	169	8.61E+4	14	2538	0.	0
16	1.81E+7	189	4.42E+4	9	2843	0.	0
18	8.66E+6	209	1.77E+4	5	3149	0.	0
19	1.02E+7	230	1.65E+4	6	3454	0.	0
21	6.56E+6	250	6.21E+3	3	3760	0.	0
23	1.25E+7	271	5.50E+3	3	4065	0.	0
25	1.51E+7	291	4.87E+3	3	4370	0.	0
27	7.61E+6	311	4.31E+3	4	4676	0.	0
IWC	1.01E-3		3.17E-3			5.78E-6	

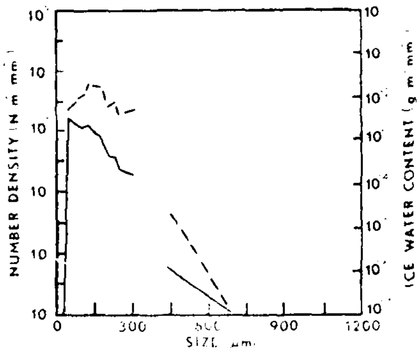


Figure 38. Representative Particle Spectrum for a 15-sec Interval During Pass 7 Through Moderately Heavy Cs on 2 February 1979

02 FEB 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	21:11:00	15	-43.1	9.6	.0042	100	46	88329	.70	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	1.43E+6	26	3.13E+6	9	437	0.	0
3	9.27E+6	47	2.22E+6	21	706	0.	0
5	2.64E+7	67	1.19E+6	23	1011	0.	0
7	6.57E+7	87	5.09E+5	16	1316	0.	0
9	7.14E+7	108	2.33E+5	11	1622	0.	0
11	5.43E+7	128	8.08E+4	6	1927	0.	0
12	4.21E+7	148	4.47E+4	4	2233	0.	0
14	3.43E+7	169	1.44E+4	2	2538	0.	0
16	3.64E+7	189	1.04E+4	2	2843	0.	0
18	3.28E+7	209	9.43E+3	2	3149	0.	0
19	3.57E+7	230	6.22E+3	2	3454	0.	0
21	4.00E+7	250	2.31E+3	1	3760	0.	0
23	2.93E+7	271	1.41E+3	1	4065	0.	0
25	2.43E+7	291	8.65E+2	<1	4370	0.	0
27	4.29E+6	311	5.30E+2	<1	4676	0.	0
IWC	2.11E-3		4.25E-3			0.	

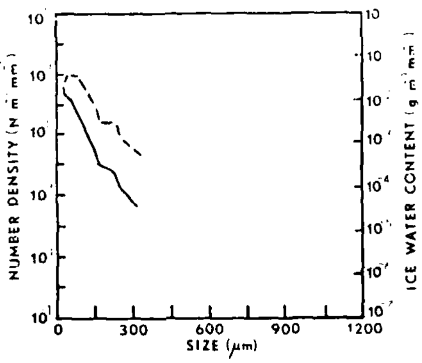


Figure 39. Representative Particle Spectrum for a 15-sec Interval During Pass 8 in Tops of Cs on 2 February 1979

02 FEB 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	21:27:00	15	-44.0	9.6	.0006	100	55	8590	.85	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	0.	26	1.37E+5	3	437	0.	0
3	0.	47	1.08E+5	7	706	0.	0
5	2.93E+6	67	8.43E+4	12	1011	0.	0
7	1.10E+7	87	1.06E+5	25	1316	0.	0
9	1.47E+7	108	7.87E+4	28	1622	0.	0
11	1.83E+7	128	2.79E+4	14	1927	0.	0
12	2.27E+7	148	1.50E+4	11	2233	0.	0
14	1.47E+7	169	1.65E+3	1	2538	0.	0
16	1.25E+7	189	0.	0	2843	0.	0
18	8.80E+6	209	0.	0	3149	0.	0
19	8.79E+6	230	0.	0	3454	0.	0
21	6.59E+6	250	0.	0	3760	0.	0
23	5.87E+6	271	0.	0	4065	0.	0
25	6.59E+6	291	0.	0	4370	0.	0
27	5.87E+6	311	0.	0	4676	0.	0
IWC	6.32E-4		5.92E-4			0.	

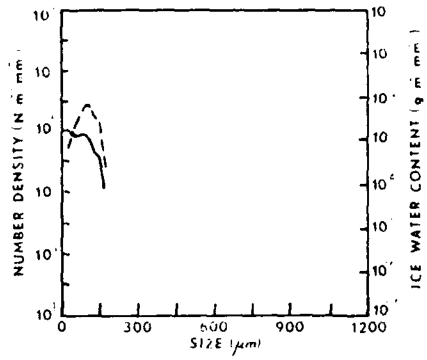


Figure 40. Representative Particle Spectrum for a 15-Sec Interval During Pass 9 In Very Thin Ci on 2 February 1979

02 FEB 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G/M**3	IWC % CLD	D0 MU	NT N/M**3	FF	PART TYPE
	22:07:00	15	-38.3	9.0	.0060	100	53	100551	.72	BR

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	0.	26	1.86E+6	4	437	0.	0
3	1.33E+7	47	1.80E+6	12	706	0.	0
5	1.40E+7	67	1.24E+6	17	1011	0.	0
7	3.84E+7	87	9.28E+5	21	1316	0.	0
9	3.55E+7	108	6.20E+5	22	1622	0.	0
11	4.06E+7	128	2.07E+5	10	1927	0.	0
12	3.10E+7	148	7.04E+4	5	2233	0.	0
14	2.51E+7	169	2.16E+4	2	2538	0.	0
16	2.36E+7	189	2.15E+4	2	2843	0.	0
18	2.29E+7	209	1.56E+4	2	3149	0.	0
19	2.14E+7	230	1.08E+4	2	3454	0.	0
21	2.51E+7	250	2.38E+3	1	3760	0.	0
23	2.81E+7	271	1.46E+3	<1	4065	0.	0
25	2.29E+7	291	8.93E+2	<1	4370	0.	0
27	1.55E+7	311	5.47E+2	<1	4676	0.	0
IWC	1.82E-3		6.00E-3			0.	

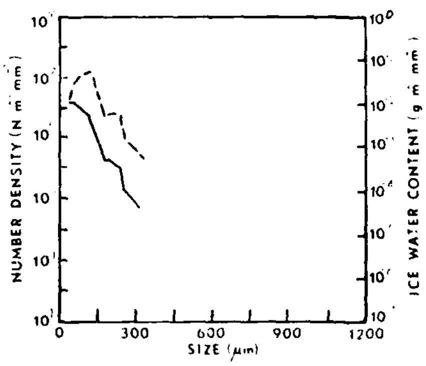


Figure 41. Representative Particle Spectrum for a 15-sec Interval During Pass 10 Through Heavy Cs on 2 February 1979

02 FEB 79	START TIME	INTVL SEC	TEMP C	ALT KM	IWC G M**3	LWC	MD MU	NT N/M**3	FF	PART TYPE
	22:29:00	15	-38.7	8.9	.0006	100	47	11400	.82	9F

PARTICLE SIZE DISTRIBUTION (N/M**3-MM)

SIZE (MU)	SCATTER PROBE	SIZE (MU)	CLOUD PROBE	PERCENT IWC/MM	SIZE (MU)	PRECIP PROBE	PERCENT IWC/MM
2	2.94E+6	26	2.75E+5	6	437	0.	0
3	2.21E+6	47	2.89E+5	19	706	0.	0
5	5.15E+6	67	1.86E+5	25	1011	0.	0
7	8.08E+6	87	1.36E+5	30	1316	0.	0
9	8.09E+6	108	3.09E+4	10	1622	0.	0
11	5.14E+6	128	1.27E+4	6	1927	0.	0
12	4.41E+6	148	0.	0	2233	0.	0
14	6.61E+6	169	1.65E+3	1	2538	0.	0
16	5.88E+6	189	0.	0	2843	0.	0
18	2.21E+6	209	1.94E+3	3	3149	0.	0
19	5.88E+6	230	0.	0	3454	0.	0
21	2.94E+6	250	0.	0	3760	0.	0
23	6.62E+6	271	0.	0	4065	0.	0
25	2.94E+6	291	0.	0	4370	0.	0
27	0.	311	0.	0	4676	0.	0
IWC	2.76E-4		6.14E-4			0.	

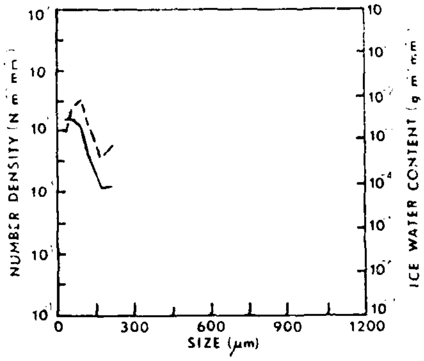


Figure 42. Representative Particle Spectrum for a 15-sec Interval During Pass 11 in Very Thin Ci on 2 February 1979

7. SUBVISIBLE CIRRUS

Barnes[21] and Cohen and Barnes[6] have observed two types of subvisible cirrus. The most frequent type is a continuous background of particles in the smallest channels of the ASSP (2 to 12 μm). This type of distribution has frequently been observed in extensive cloud-free areas sampled by the MC-130E during calibration flights or while en route to or from sampling locations. It was thought to be noise, but data-free periods, such as seen in Figure 36, have shown the data to be real. A second type of subvisible cirrus consists of isolated ice crystals, generally 100 μm or greater in diameter, occasionally exceeding 1000 μm. They have been detected on the PMS 1-D and 2-D probes and visually verified on the snow stick. Although generally observed while under cirrus clouds, they have also been found with no cloud above the airplane. They may form in moist layers high in the troposphere and fall to lower layers. In the Arctic region, they fall to the surface and are called "diamond dust." In warmer climates, they melt, evaporate, or are lost among other aerosols (fog, dust, sea spray, pollution, and so on) before reaching the surface.

Although the purpose of these flights was to obtain data in clouds, there were periods during which the airplane was in what appeared to be clear air. During

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21. Barnes, A.A., Jr. (1980) Ice Particles in Clear Air. Communications a la VIII ème Conférence Internationale sur la Physique des Nuages, Vol. I., Clermont-Ferrand, France, 15-19 July 1980, pp 189-190.

those times, there were occasions when particles were detected which indicated the presence of subvisible cirrus.

During three short periods on 28 January (2115:00 to 2121:45Z, 2129:15 to 2132:15Z, and 2205:00 to 2208:15Z), the airplane appeared to be in clear air, yet particles were detected. During the first and second, no small particles appeared on the ASSP, but a few larger particles (probably fallout from higher clouds) typical of the second type of subvisible cirrus were recorded. During the third period, the ASSP detected only a background of small particles typical of the first type of subvisible cirrus.

On 29 January, from 1901:45 to 1919:00Z, the ASSP showed results similar to those observed during the third period on 28 January but in addition, individual particles were also detected by the cloud and precipitation probes.

On 2 February (see Figure 36), from 2131:15 to 2157:00Z, no small particles were detected by the ASSP, but some subvisible cirrus particles greater than 50 μm in diameter were recorded by the cloud probe. The density of 50-μm particles was 21 m^{-3}. Particles greater than 100 μm had a density of 7 m^{-3}, which is considerably higher than the 0.12 m^{-3} found by Barnes[21] in a cloud-free atmosphere at 5 km on 2 February 1980, using a modified 2-D precipitation probe. The larger number of subvisible cirrus particles may be due to additional moisture in the air due to the presence of visible clouds in the vicinity.

8. CONCLUDING COMMENTS

The three cirriform cloud sampling flights of 28 and 29 January and 2 February 1979 have added considerably to the small base of such data now available. The first and third flights were made in the vicinity of bands of cirriform clouds ahead of surface systems and close to jet stream winds. In the first case, the surface systems were intensifying, while in the third case, they were weak and dissipating. The second flight was made through the top portions of Cs and Cc clouds at the top of an active surface storm.

The 28 January flight encountered a variety of types of cirrostratus. The presence of larger particles at certain times during that flight indicate that aggregation of smaller particles into larger particles was probably occurring. We attribute this to the deepening of the low pressure areas to the south and west of the sampling area.

The 29 January flight through the top of the storm provided quite high particle counts, sometimes exceeding 300,000 m^{-3}. Even with this large number, however, the particle sizes were seldom greater than 1100 μm, while typical ice water contents were near 0.03 g m^{-3}. Since the tropopause was relatively low on this day, we were able to acquire data at temperatures as low as -48°C. The large

number of particles detected may have been related both to their generation in or near the storm and also to the fact that we were able to sample at colder locations in the cloud than usually possible with the C-130.

The cirrostratus layers sampled on 28 January and 2 February were of different consistencies, although the in-flight meteorologist occasionally noted they were both heavy or moderately heavy clo id forms. On the first day, with a developing storm in the area, the largest particle sizes in two passes through or along the Cs were near 1400 μm, while n ean IWC values were 1 to 2×10^{-2} g m^{-3} and the median volume diameter was 130 to 140 μm.

The Cs on 2 February with only weak, dissipating surface systems in the area, had maximum particle sizes near or less than 500 μm and a mean IWC of 7×10^{-3} g m^{-3} or less. Median volume diameters were also generally less than 90 μm. Pass 10 on 2 February was considered by the mission director to be a sample of heavy Cs, while Passes 9 and 11 were through very thin cirriform clouds. It is interesting that the largest particles detected, L_{max}, in each of these cases were not significantly different. The median volume diameters were also near 55 μm in each of the 3 cases. However, the number of particles, NT, was much greater, 99, 000 m^{-3}, in the heavy Cs case, while the thinner cirrus examples had mean NT less than 13, 000 m^{-3}. The larger particle count in the heavy Cs case also resulted in a greater ice mass than in the cases of the thinner cloud samples.

This is the first report in this series that has described and discussed total particle counts (NT), maximum particle size (L_{max}) and form factor (FF). As described above, the NT and L_{max} aid considerably in efforts to characterize particle data. The form factor has also been found useful in understanding the variation of particle spectra. Form factor values in the relatively low range of 0. 20 to 0. 45 are frequently associated with approximately exponential decreases of particle numbers out to sizes as large as 1000 to 2000 μm (in cirrus samples). Values of FF above approximately 0. 70 are often related to spectra that extend only to particle sizes of 300 μm or less. Form factor calculations based on data from less than about 10 spectrometer channels are less reliable and meaningful, but a small number of cases indicates that, even here, high values of FF are associated with abbreviated spectra.

Two types of subvisible cirrus were detected during these flights. A continuous background of small particles was observed while in clear air during the first two flights. Occasional larger particles were observed in clear air on all three days.

Cirrus flights were conducted on the three days immediately following the 2 February flight. The results of these flights will be discussed in a future report.

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Appendix A

28 January 1979 Data Tabulations

The example below explains the data format used in the tabulations that follow. The comments provided are from notes made during the flight by the mission director.

1 2 3 4 5 6 7 8 9 10 11 12

02 FEB 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF
20:55:00	9.1	-38.7	.0016	.0038	99	69	35385	437	.66
20:55:15	9.1	-38.5	.0019	.0042	100	63	52414	311	.65
20:55:30	9.1	-38.4	.0025	.0050	99	69	58656	437	.56
20:55:45	9.1	-38.4	.0016	.0052	99	77	39564	437	.61
20:56:00	9.1	-38.5	.0013	.0044	100	71	46072	311	.57
20:56:15	9.1	-38.6	.0013	.0037	100	70	34446	311	.63
20:56:30	9.1	-38.8	.0020	.0043	99	84	32615	437	.56
20:56:45	9.1	-38.8	.0014	.0052	99	72	45554	437	.63
20:57:00	9.1	-38.9	.0028	.0065	99	61	91805	437	.59

1. Start time of sample. End was 14 sec later. Time in UMT.
2. Mean altitude of sample (km).
3. Mean temperature of sample ($^{\circ}C$).
4. Date of sampling.
5. Ice water content in g/m^3 calculated over 2 to 27-μm range of scatter probe.

6. Ice water content in g/m^3 calculated over 26 to 4700-μm range of cloud and precip probes.
7. Duration of each sample (sec).
8. Percent of total ice water content of 6 determined from cloud probe only.
9. Median volume diameter of equivalently melted particles. (D_o in the text)
10. Particle number total $/m^3$ over 47 to 4700 μm size range. (The first channel of the cloud probe is not used to compute this value.)
11. Greatest size having ≥ 1 particle m^{-3} mm^{-1} (in μm).
12. Form Factor (see text).

START TIME	ALT KM	28 JAN 79 TEMP C	IWC-SC G/M**3	15 SECOND AVERAGE IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
21:15:00	7.8	-31.4	0.0000	0.0000	0	0	0	0	0.00	Heading 090° (East); 31°48'N, 105°32'W, TAS 220 kt; GS 320 kt. Cirrus layer above.
21:15:15	7.8	-31.2	0.0000	0.0000	0	0	0	0	0.00	
21:15:30	7.8	-31.0	0.0000	0.0000	0	0	0	0	0.00	
21:15:45	7.8	-30.9	0.0000	0.0000	0	0	0	0	0.00	
21:16:00	7.8	-31.0	.0000	0.0000	0	0	0	3	0.00	Within 2-3,000 ft of cirrus above, but no particle counts yet.
21:16:15	7.8	-31.2	0.0000	0.0000	0	0	0	0	0.00	
21:16:30	7.9	-31.2	0.0000	0.0000	0	0	0	0	0.00	
21:16:45	7.9	-31.5	0.0000	0.0000	0	0	0	0	0.00	
21:17:00	7.9	-31.7	0.0000	0.0000	0	0	0	0	0.00	Breaks in the cirrostratus above. Blue sky occasionally visible
21:17:15	7.9	-31.8	0.0000	0.0000	0	0	0	0	0.00	
21:17:30	7.9	-31.8	0.0000	0.0000	0	0	0	0	0.00	
21:17:45	8.0	-31.9	.0000	0.0000	0	0	0	2	0.00	
21:18:00	8.0	-32.0	0.0000	0.0000	0	0	0	0	0.00	
21:18:15	8.0	-31.8	0.0000	0.0000	0	0	0	0	0.00	
21:18:30	8.0	-30.9	.0000	0.0000	0	0	0	2	0.00	At 31° 47'N, 105°09'W.
21:18:45	8.0	-30.6	0.0000	0.0000	0	0	0	0	0.00	
21:19:00	8.0	-30.7	0.0000	0.0000	0	0	0	0	0.00	
21:19:15	8.0	-30.7	0.0000	0.0000	0	0	0	0	0.00	
21:19:30	8.0	-30.7	0.0000	0.0000	0	0	0	0	0.00	
21:19:45	8.1	-30.5	0.0000	0.0000	0	0	0	0	0.00	
21:20:00	8.1	-30.2	0.0000	0.0000	0	0	0	0	0.00	
21:20:15	8.1	-30.4	.0000	.0002	92	123	1349	437	.38	
21:20:30	8.1	-30.5	.0001	.0002	94	104	544	437	.64	
21:20:45	8.1	-30.4	.0000	.0001	100	69	1281	169	.77	Getting very near cirriform cloud base.
21:21:00	8.2	-30.4	0.0000	0.0000	0	0	0	0	0.00	
21:21:15	8.2	-30.1	0.0000	0.0000	0	0	0	0	0.00	
21:21:30	8.2	-30.6	0.0000	0.0000	0	0	0	0	0.00	
21:21:45	8.2	-30.7	0.0000	0.0000	0	0	0	0	0.00	
21:22:00	8.2	-30.8	.0000	.0007	9	248	395	1316	.31	About to pass through a jagged piece of the Cs base.
21:22:15	8.2	-31.0	.0021	.0112	6	368	8519	2233	.14	At 31°46'N, 104°45'W. Ground and horizon are dimly visible through cirrostratus
21:22:30	8.3	-31.4	.0024	.0117	24	198	20166	1622	.21	base that is nearly without texture. Not possible to estimate tops.
21:22:45	8.3	-31.8	.0034	.0108	55	136	23836	1011	.41	
21:23:00	8.4	-32.3	.0014	.0065	82	113	23384	706	.48	Moved out of thicker cloud, but more is coming.
21:23:15	8.4	-32.4	.0001	.0001	90	64	1227	437	.44	
21:23:30	8.4	-32.2	.0000	.0001	100	133	473	311	.43	
21:23:45	8.4	-31.9	.0002	.0005	100	89	3195	311	.61	
21:24:00	8.4	-32.0	.0002	.0009	100	87	4684	311	.65	
21:24:15	8.4	-32.2	.0000	.0000	100	63	469	169	.74	At 31°48'N, 104°31'W. Cirriform cloud base now about 1000 ft above. Visibility
21:24:30	8.4	-32.0	.0003	.0011	99	107	4537	437	.60	is less ahead.
21:24:45	8.4	-32.1	.0006	.0037	65	123	8934	1011	.43	
21:25:00	8.5	-32.0	.0025	.0143	19	227	16255	1316	.26	In milky textured cloud now.
21:25:15	8.5	-32.3	.0005	.0021	65	125	5882	706	.43	
21:25:30	8.6	-32.6	.0002	.0005	99	92	2435	437	.63	
21:25:45	8.6	-32.7	.0004	.0011	99	100	4074	437	.67	Apparently getting larger counts now. Climbing.
21:26:00	8.6	-32.9	.0000	.0002	100	124	877	311	.49	
21:26:15	8.6	-33.2	.0001	.0003	100	94	1536	311	.59	
21:26:30	8.6	-33.1	.0006	.0023	99	111	7746	437	.64	
21:26:45	8.6	-33.3	.0003	.0008	100	79	5258	250	.73	Breaks of blue sky through relatively light cirriform clouds above.
21:27:00	8.6	-33.5	.0011	.0044	98	108	19171	437	.57	
21:27:15	8.6	-33.5	.0003	.0011	97	89	4751	437	.66	
21:27:30	8.7	-33.6	.0000	.0002	100	83	1173	250	.73	
21:27:45	8.7	-33.5	.0001	.0008	100	76	5177	311	.57	
21:28:00	8.7	-33.4	.0002	.0007	100	85	3401	311	.69	At 31°51'N, 104°06'W. Wind measured to be 241°/141 kt.
21:28:15	8.6	-33.3	0.0000	0.0000	0	0	0	0	0.00	A layer of altocumulus is several thousand feet below. Base of visible Cs is about
21:28:30	8.6	-33.0	.0000	.0000	100	56	140	108	1.58	1000 ft above the aircraft.
21:28:45	8.6	-33.2	.0004	.0010	83	84	7556	706	.36	

START	ALT	28 JAN 79 TEMP	IWC-SC	15 SECOND AVERAGE IWC-CP	IWC	DO	NT	LMAX	FF	
TIME	KM	C	G/M**3	G/M**3	% CLD	UM	N/M**3	UM		
21:29:00	8.7	-33.6	.0009	.0040	60	129	11193	1011	.37	
21:29:15	8.7	-33.5	.0000	.0000	90	60	295	437	.44	At 31°51'N, 103°58'W. Visibility is good, but Ac undercast obscures ground. A few patches of blue sky through Cs above.
21:29:30	8.7	-33.6	0.0000	0.0000	0	0	0	0	0.00	
21:29:45	8.7	-33.8	0.0000	0.0000	0	0	0	0	0.00	
21:30:00	8.7	-33.9	0.0000	0.0000	0	0	0	0	0.00	Between cloud layers. Probably very few particle counts now.
21:30:15	8.7	-33.9	0.0000	0.0000	0	0	0	0	0.00	
21:30:30	8.7	-33.6	0.0000	0.0000	0	0	0	0	0.00	Will pass through a piece of Cs base soon.
21:30:45	8.6	-33.0	0.0000	0.0000	0	0	0	0	0.00	
21:31:00	8.6	-32.8	.0000	0.0000	0	0	0	7	0.00	Complete undercast below.
21:31:15	8.6	-32.6	0.0000	0.0000	0	0	0	0	0.00	
21:31:30	8.6	-32.6	0.0000	0.0000	0	0	0	0	0.00	
21:31:45	8.6	-32.6	.0000	.0000	100	49	809	128	.80	
21:32:00	8.6	-32.6	.0000	0.0000	0	0	0	14	0.00	
21:32:15	8.5	-32.4	.0000	.0001	15	316	38	706	.40	At 31°49'N, 103°38'W. Wind is 243°/138 kt. Very dark cloud ahead.
21:32:30	8.5	-32.4	.0017	.0104	59	131	29134	1011	.38	
21:32:45	8.5	-32.3	.0033	.0130	82	118	48676	706	.46	
21:33:00	8.5	-32.3	.0001	.0001	96	50	1075	437	.54	
21:33:15	8.5	-32.3	.0000	.0000	100	51	103	87	1.00	
21:33:30	8.5	-32.1	0.0000	0.0000	0	0	0	0	0.00	Visibility has improved. Very near base of Cs overcast.
21:33:45	8.5	-32.0	.0000	.0001	38	319	43	706	.55	
21:34:00	8.5	-32.0	.0000	.0000	0	242	2	437	1.41	At 31°48'N, 103°29'W.
21:34:15	8.5	-32.2	0.0000	0.0000	0	0	0	0	0.00	Momentarily between layers. Nearing dark cloud ahead.
21:34:30	8.5	-32.1	.0003	.0017	50	140	4372	1011	.30	
21:34:45	8.5	-32.0	.0044	.0175	63	128	50424	1011	.41	Can't see ground through undercast.
21:35:00	8.5	-32.1	.0039	.0163	72	124	43049	706	.48	Visibility approximately 1 mi, but nothing to gauge against.
21:35:15	8.5	-32.1	.0036	.0158	80	113	50218	706	.49	
21:35:30	8.5	-32.0	.0080	.0305	74	122	88315	1011	.47	
21:35:45	8.5	-32.0	.0052	.0210	81	115	70952	706	.49	Milky white in all directions.
21:36:00	8.5	-32.1	.0032	.0140	76	115	47303	1011	.45	
21:36:15	8.5	-32.1	.0049	.0255	65	126	66775	1011	.44	Still very foggy, only a hint of blue sky above.
21:36:30	8.5	-32.1	.0043	.0188	73	121	47372	1316	.45	
21:36:45	8.5	-32.0	.0035	.0143	81	117	43060	706	.51	Beginning a left turn at 31°49'N, 103°07'W. Wind 245°/142 kt
21:37:00	8.4	-31.9	.0010	.0025	74	121	8414	706	.44	
21:37:15	8.5	-31.9	.0004	.0012	66	130	4319	706	.40	
21:37:30	8.5	-32.0	.0006	.0014	86	85	8220	706	.43	Still in heavy Cs. Visibility difficult to gauge.
21:37:45	8.5	-32.0	.0011	.0047	72	119	13812	706	.46	
21:38:00	8.5	-32.0	.0006	.0033	55	136	5303	1011	.49	
21:38:15	8.5	-32.1	.0007	.0042	52	138	7473	1011	.43	
21:38:30	8.5	-32.0	.0031	.0167	56	134	46147	1011	.36	Visibility very low. No breaks of blue above.
21:38:45	8.5	-31.8	.0079	.0340	46	148	66408	1011	.37	
21:39:00	8.5	-31.5	.0135	.0862	27	202	132399	2538	.15	Foggy white in all directions, but can see texture of Ac below. At 31°56'N, 102°02'W
21:39:15	8.5	-31.7	.0132	.0765	32	184	138669	2233	.17	
21:39:30	8.5	-31.6	.0107	.0593	34	181	123978	2233	.20	
21:39:45	8.5	-31.9	.0068	.0356	51	139	71952	1316	.38	
21:40:00	8.5	-31.8	.0090	.0351	59	130	93211	1316	.39	Wind 245°/134 kt, heading 219°, [illegible]S 100 kt.
21:40:15	8.5	-32.0	.0063	.0301	50	140	63290	1011	.39	
21:40:30	8.5	-31.8	.0073	.0345	57	133	85994	1316	.39	
21:40:45	8.5	-31.9	.0072	.0300	66	129	75690	1011	.45	
21:41:00	8.4	-31.8	.0047	.0187	84	116	58109	706	.53	
21:41:15	8.4	-31.8	.0023	.0122	75	122	32940	706	.50	
21:41:30	8.4	-31.7	.0063	.0230	53	138	58456	1011	.39	Approximately in middle of Cs layer. Can see sun shining dimly above. Nothing to see for a picture.
21:41:45	8.4	-31.6	.0053	.0198	39	162	41675	1011	.34	
21:42:00	8.4	-31.7	.0017	.0087	52	138	18664	1316	.37	
21:42:15	8.4	-31.6	.0060	.0291	53	137	60939	1316	.41	
21:42:30	8.4	-31.7	.0048	.0198	34	174	33933	1011	.33	
21:42:45	8.4	-31.7	.0054	.0134	24	213	29575	1316	[illegible]	

28 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
21:43:00	8.4	-31.8	.0030	.0135	19	214	26168	1316	.23	Heading 200°, TAS 235 kt, [illegible] W, wind [illegible] 12 kt.
21:43:15	8.4	-31.9	.0035	.0137	13	230	18765	2233	.18	
21:43:30	8.4	-32.1	.0010	.0021	26	195	4641	1316	.22	
21:43:45	8.4	-32.0	.0015	.0059	23	194	6869	1316	.30	
21:44:00	8.4	-31.8	.0012	.0038	34	171	5570	1011	.37	
21:44:15	8.4	-32.1	.0007	.0057	56	136	7905	1011	.54	
21:44:30	8.5	-32.6	.0038	.0200	83	116	48450	706	.58	
21:44:45	8.5	-32.8	.0030	.0158	76	120	34272	706	.56	
21:45:00	8.5	-32.8	.0009	.0038	54	137	9636	1011	.39	
21:45:15	8.6	-32.8	.0036	.0174	63	126	71956	1011	.33	
21:45:30	8.6	-32.8	.0059	.0252	72	112	101685	706	.39	
21:45:45	8.6	-33.0	.0035	.0148	70	122	39268	1011	.46	
21:46:00	8.6	-33.1	.0013	.0038	69	125	10819	706	.45	Still dense Cs, no breaks. No accumulation of particles on snow stick.
21:46:15	8.6	-33.1	.0023	.0121	68	126	24017	1011	.52	
21:46:30	8.7	-33.5	.0031	.0176	45	151	28160	1011	.43	
21:46:45	8.7	-34.1	.0035	.0184	59	132	39885	1011	.44	At 31°45'N, 103°08'W, GS 86 kt. Climbing.
21:47:00	8.7	-34.1	.0048	.0255	51	139	47705	1316	.43	
21:47:15	8.8	-34.2	.0058	.0265	48	144	47046	1316	.42	Still heavy Cs. No breaks.
21:47:30	8.8	-34.2	.0061	.0272	39	162	52506	1316	.35	
21:47:45	8.8	-34.6	.0053	.0219	70	128	50463	706	.50	
21:48:00	8.9	-34.8	.0053	.0237	78	110	75902	706	.48	
21:48:15	8.9	-34.7	.0081	.0272	40	161	66294	1316	.31	
21:48:30	8.9	-35.1	.0043	.0096	31	177	22555	1011	.29	Heading 251°, GS 105 kt, at 31°45'N, 103°12'W.
21:48:45	8.9	-35.2	.0035	.0180	61	132	37942	1011	.47	
21:49:00	8.9	-35.3	.0037	.0113	63	128	30894	706	.42	
21:49:15	8.9	-35.2	.0103	.0458	59	131	94240	2538	.25	Still dense cloud, no texture.
21:49:30	8.9	-35.3	.0089	.0408	70	123	102271	1011	.48	
21:49:45	9.0	-35.6	.0069	.0262	81	103	110194	706	.45	
21:50:00	8.9	-35.6	.0026	.0104	73	117	41456	1316	.34	
21:50:15	8.9	-35.6	.0019	.0070	62	127	20382	1011	.40	Interior of Cs slightly brighter now. At 31°48'N, 103°17'W. Cloud tops about
21:50:30	9.0	-35.7	.0007	.0023	39	161	2680	1011	.46	2-3000 ft above aircraft.
21:50:45	9.0	-36.0	.0001	.0003	56	136	351	706	.65	
21:51:00	9.0	-36.1	.0010	.0018	99	52	32210	437	.78	
21:51:15	9.0	-36.1	.0010	.0020	100	53	34776	230	.74	
21:51:30	9.0	-35.9	.0005	.0009	99	57	13654	437	.73	
21:51:45	9.0	-36.2	.0001	.0003	96	100	1440	437	.50	
21:52:00	9.1	-36.7	.0001	.0004	89	106	1619	437	.50	Can see texture of Ac below. Turning to left.
21:52:15	9.2	-37.5	.0001	.0004	92	130	1730	437	.49	
21:52:30	9.1	-37.2	.0003	.0008	55	133	2095	706	.37	Visibility good to north. Can see Ac below, Cs above. Approaching more dense cloud.
21:52:45	9.1	-36.8	.0012	.0053	36	170	9473	1316	.30	
21:53:00	9.1	-37.1	.0049	.0219	49	143	72833	1316	.25	
21:53:15	9.1	-36.8	.0064	.0363	46	149	70540	1622	.34	
21:53:30	9.1	-36.7	.0080	.0388	60	127	124760	1316	.34	
21:53:45	9.1	-37.1	.0062	.0196	64	107	142307	1316	.21	
21:54:00	9.2	-37.1	.0050	.0192	53	134	79010	1316	.23	
21:54:15	9.2	-37.1	.0039	.0146	63	114	79981	1316	.24	Sun dimly visible. No texture to foggy cloud.
21:54:30	9.2	-37.2	.0036	.0118	54	126	72668	1316	.17	
21:54:45	9.2	-37.2	.0040	.0133	68	112	79583	706	.30	
21:55:00	9.2	-37.0	.0015	.0051	54	131	28110	1011	.22	
21:55:15	9.2	-37.1	.0009	.0034	43	160	21236	1011	.17	
21:55:30	9.2	-37.0	.0012	.0037	64	103	27191	1011	.21	At 31°37'N, 103°00'W. Heading 165°. Sun fairly bright, but aircraft is not yet
21:55:45	9.2	-37.0	.0013	.0022	86	72	25957	706	.33	near Cs top. No accumulation on snow stick.
21:56:00	9.2	-36.7	.0008	.0013	93	67	15458	437	.41	
21:56:15	9.2	-36.6	.0030	.0053	99	57	81100	437	.58	
21:56:30	9.2	-36.8	.0015	.0027	99	54	43035	437	.54	
21:56:45	9.2	-36.4	.0002	.0004	64	88	4211	706	.22	

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
		28 JAN 79		15 SECOND AVERAGE						
21:57:00	9.2	-36.4	.0003	.0010	82	75	10164	706	.31	Not possible to ascend higher, must descend slightly. No texture in heavy cloud.
21:57:15	9.2	-36.4	.0006	.0015	77	106	7327	706	.39	Visibility approx. 1 mi. Can not see any particles passing by.
21:57:30	9.1	-36.3	.0012	.0047	65	122	14478	1011	.39	
21:57:45	9.0	-36.4	.0025	.0114	57	131	38208	1011	.33	
21:58:00	9.0	-35.9	.0041	.0174	58	128	69663	1316	.26	
21:58:15	9.0	-35.8	.0074	.0280	62	114	141666	1316	.23	
21:58:30	8.9	-35.5	.0052	.0192	57	130	95519	1011	.26	
21:58:45	8.9	-35.5	.0012	.0032	58	129	9332	1011	.36	Breaking out a little between Ac below and higher Cs. Visibility about 40 mi.
21:59:00	8.9	-35.4	.0007	.0013	70	115	4305	706	.42	A little blue sky above, but 8/10 cloud coverage. Beginning a turn to go back
21:59:15	8.9	-35.3	.0001	.0003	95	108	1641	437	.53	into heavy cloud.
21:59:30	8.9	-35.4	.0001	.0005	97	102	3471	437	.47	
21:59:45	8.9	-35.2	.0001	.0003	42	256	1007	706	.20	
22:00:00	8.9	-35.4	.0003	.0010	49	142	2128	706	.39	At 31°39'N, 103°02'W. Wind is 238°/137 kt, GS 363 kt.
22:00:15	8.9	-35.5	.0021	.0059	50	141	17085	1316	.30	
22:00:30	8.9	-35.6	.0033	.0116	59	130	33157	1011	.37	Back into dense Cs, like heavy fog. No breaks above.
22:00:45	8.9	-35.5	.0025	.0096	68	123	32134	1011	.40	
22:01:00	8.9	-35.1	.0033	.0135	74	110	57282	706	.40	
22:01:15	8.9	-35.2	.0039	.0212	54	136	62368	1316	.32	
22:01:30	8.9	-35.1	.0084	.0355	46	149	125432	2233	.19	
22:01:45	8.8	-34.9	.0097	.0469	45	151	128091	1316	.26	
22:02:00	8.8	-34.4	.0049	.0245	32	178	41808	1316	.29	Must begin a slight descent to maintain IAS of 150 kt.
22:02:15	8.8	-34.7	.0047	.0208	52	138	39878	1011	.42	
22:02:30	8.8	-34.4	.0029	.0099	26	198	19962	1316	.23	
22:02:45	8.7	-34.2	.0016	.0069	15	274	8492	1927	.18	
22:03:00	8.7	-33.9	.0005	.0040	20	210	3211	1316	.34	
22:03:15	8.6	-33.6	.0004	.0025	47	146	2216	706	.62	
22:03:30	8.6	-33.1	.0002	.0012	83	95	4924	706	.49	
22:03:45	8.6	-33.1	.0003	.0009	81	100	5184	706	.40	
22:04:00	8.6	-33.2	.0001	.0003	96	59	3197	706	.40	At 31°54'N, 102°50'W. Now between cloud layers. Undercast below. **A little blue**
22:04:15	8.6	-33.1	.0002	.0008	78	101	2895	706	.48	sky visible to north. About 1000 ft below Cs base.
22:04:30	8.6	-33.3	.0001	.0003	67	120	620	706	.50	
22:04:45	8.6	-33.5	.0001	.0002	55	136	304	706	.50	
22:05:00	8.6	-33.1	.0000	0.0000	0	0	0	9	0.00	
22:05:15	8.6	-32.8	.0000	0.0000	0	0	0	18	0.00	
22:05:30	8.6	-32.9	.0000	0.0000	0	0	0	19	0.00	
22:05:45	8.6	-33.1	0.0000	0.0000	0	0	0	0	0.00	
22:06:00	8.6	-33.2	.0000	0.0000	0	0	0	18	0.00	
22:06:15	8.6	-33.4	.0000	0.0000	0	0	0	16	0.00	
22:06:30	8.6	-33.6	.0000	0.0000	0	0	0	16	0.00	
22:06:45	8.6	-33.5	.0000	0.0000	0	0	0	18	0.00	Still between layers.
22:07:00	8.6	-33.6	.0000	0.0000	0	0	0	18	0.00	
22:07:15	8.6	-33.8	.0000	0.0000	0	0	0	16	0.00	
22:07:30	8.6	-33.7	.0000	0.0000	0	0	0	18	0.00	
22:07:45	8.6	-33.7	.0000	0.0000	0	0	0	16	0.00	
22:08:00	8.6	-33.6	.0001	0.0000	0	0	0	23	0.00	
22:08:15	8.6	-33.7	.0001	.0000	100	33	362	47	1.00	
22:08:30	8.6	-33.5	.0002	.0003	99	47	5003	437	.68	In heavier Cs. Can see texture of Ac undercast below. **Aircraft is in base of Cs.**
22:08:45	8.7	-33.5	.0028	.0134	87	95	60383	706	.49	Blue sky dimly visible above.
22:09:00	8.6	-33.5	.0024	.0087	76	113	39815	706	.40	
22:09:15	9.6	-33.4	.0049	.0193	66	119	83348	1011	.33	
22:09:30	8.6	-33.4	.0096	.0622	18	215	70112	2233	.19	
22:09:45	8.6	-33.3	.0137	.0812	18	222	105146	2233	.19	
22:10:00	8.6	-33.5	.0032	.0116	53	138	24753	1011	.43	Have broken out of Cs again.
22:10:15	8.6	-33.4	.0002	.0000	78	79	34	437	.57	
22:10:30	8.6	-33.3	.0002	0.0000	0	0	0	27	0.00	
22:10:45	8.6	-33.4	.0001	0.0000	0	0	0	27	0.00	

28 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
22:11:00	8.6	-33.5	.0001	0.0000	0	0	0	25	0.00	
22:11:15	8.6	-33.7	.0000	.0001	100	78	684	230	.82	
22:11:30	8.6	-33.6	.0004	.0020	100	84	9404	311	.72	
22:11:45	8.6	-33.6	.0001	.0002	100	116	602	311	.71	
22:12:00	8.6	-33.7	.0001	.0003	100	115	566	311	.77	
22:12:15	8.6	-33.9	.0000	.0000	0	242	1	437	1.41	
22:12:30	8.6	-33.8	.0001	.0002	95	76	1716	706	.44	
22:12:45	8.6	-33.7	.0002	.0007	95	130	2845	437	.46	At 31°59'N, 103°09'W. Wind is 245°/136 kt. Near base of Cs. Should be getting good particle counts.
22:13:00	8.6	-33.7	.0003	.0012	72	125	2223	706	.57	
22:13:15	8.6	-33.5	.0000	.0003	94	117	718	437	.63	
22:13:30	8.6	-33.4	.0000	.0002	100	108	336	311	.84	
22:13:45	8.6	-33.4	.0000	0.0000	0	0	0	23	0.00	
22:14:00	8.6	-33.7	.0000	.0002	98	132	677	437	.59	
22:14:15	8.6	-33.8	.0001	.0007	89	130	2286	437	.49	
22:14:30	8.6	-33.8	.0004	.0015	88	120	4881	437	.51	Only a little Ac below aircraft to the north. Ground visible. Horizontal visibility about 1 mi. in hazy Cs. Reentering heavier Cs. Can see ice particles going by.
22:14:45	8.6	-33.5	.0010	.0042	74	124	9575	706	.53	
22:15:00	8.6	-33.7	.0019	.0084	64	127	23073	1011	.42	
22:15:15	8.6	-33.8	.0025	.0119	34	173	21807	1011	.33	
22:15:30	8.6	-33.8	.0049	.0271	46	149	43963	1316	.40	
22:15:45	8.6	-33.8	.0063	.0341	40	160	63770	1927	.30	
22:16:00	8.6	-33.8	.0013	.0051	59	122	17917	1011	.29	Near base of Cs, but it's tenuous and hard to judge. Slant visibility downward about 10 mi.
22:16:15	8.6	-33.7	.0018	.0055	93	68	51101	706	.46	
22:16:30	8.6	-33.7	.0037	.0121	91	70	110598	706	.42	
22:16:45	8.6	-33.9	.0024	.0086	92	79	67651	706	.45	
22:17:00	8.6	-34.2	.0053	.0183	84	79	124795	706	.39	Only a few breaks in Cs above.
22:17:15	8.6	-34.3	.0047	.0147	90	76	121908	706	.42	
22:17:30	8.6	-34.4	.0013	.0049	90	85	32331	706	.45	
22:17:45	8.6	-34.5	.0001	.0001	53	80	406	706	.29	
22:18:00	8.6	-34.5	.0000	.0001	79	79	836	706	.29	
22:18:15	8.6	-34.3	.0000	.0000	62	67	53	437	.39	
22:18:30	8.6	-34.0	.0000	.0001	100	62	998	169	1.07	
22:18:45	8.6	-34.3	.0000	0.0000	0	0	0	27	0.00	
22:19:00	8.6	-34.3	0.0000	0.0000	0	0	0	0	0.00	Should be exiting all Cs. Much blue sky above.
22:19:15	8.6	-34.3	0.0000	0.0000	0	0	0	0	0.00	
22:19:30	8.6	-34.2	0.0000	0.0000	0	0	0	0	0.00	At 32° 16', 103° 22'. Wind 245°/140 kt. Beginning descent.

Appendix B

29 January 1979 Data Tabulations

Tabulations follow the format described in Appendix A.

29 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DØ UM	NT N/M**3	LMAX UM	FF	Remarks
10:45:00	7.7	-47.5	.0321	.0498	86	58	725730	1011	.29	
10:45:15	7.7	-47.7	.0196	.0323	89	61	434244	1011	.33	
10:45:30	7.8	-47.8	.0323	.0531	82	64	692007	1011	.27	Heading 158°, wind 210° 24 kt. In heavy Cs, but sun is visible above dimly.
10:45:45	7.7	-47.7	.0146	.0283	86	64	360023	1316	.27	
10:46:00	7.7	-47.9	.0110	.0341	92	70	352219	706	.40	
10:46:15	7.7	-47.7	.0124	.0405	87	81	310314	1011	.38	
10:46:30	7.7	-47.7	.0096	.0367	81	94	200120	1011	.40	
10:46:45	7.7	-47.7	.0046	.0092	99	63	111332	437	.56	In top of Cs. Most cloud is below. Blue sky above through thin cirriform
10:47:00	7.7	-47.6	.0071	.0063	100	52	100147	311	.56	filaments near aircraft altitude.
10:47:15	7.7	-47.6	.0134	.0192	93	56	297635	706	.39	In white, very hazy, heavy Cs overcast above, but sun is fairly bright above.
10:47:30	7.7	-47.3	.0202	.0571	81	60	676705	1316	.25	
10:47:45	7.7	-47.2	.0263	.0569	78	71	671017	2233	.14	
10:48:00	7.6	-47.1	.0253	.0592	78	76	624353	1011	.25	
10:48:15	7.6	-47.2	.0131	.0209	95	55	327753	706	.41	
10:48:30	7.6	-47.3	.0155	.0505	73	93	390364	1011	.27	Very small particles on snow stick. Heading 165° at 38°28'N, 104°26'W.
10:48:45	7.7	-47.4	.0095	.0270	99	67	315036	437	.53	
10:49:00	7.7	-47.4	.0107	.0105	99	60	271097	437	.50	
10:49:15	7.6	-47.4	.0081	.0114	99	56	174296	437	.53	
10:49:30	7.7	-47.5	.0052	.0134	99	64	159395	437	.56	
10:49:45	7.6	-47.3	.0076	.0241	94	70	199424	706	.46	
10:50:00	7.6	-47.5	.0035	.0071	100	56	109238	311	.50	Cs has thinned here in the top. Much blue sky through thin filaments.
10:50:15	7.7	-47.6	.0042	.0103	99	69	105755	437	.50	Halo around sun.
10:50:30	7.7	-47.7	.0039	.0054	99	83	37575	437	.54	
10:50:45	7.7	-47.8	.0014	.0044	100	79	40265	311	.51	
10:51:00	7.7	-48.0	.0005	.0017	100	105	11670	311	.48	
10:51:15	7.7	-47.7	.0014	.0033	100	62	43644	311	.61	
10:51:30	7.7	-47.7	.0027	.0064	99	71	65311	437	.52	Most cloud is below but some thin cloud extends 1-2,000 ft above the aircraft.
10:51:45	7.7	-47.3	.0037	.0083	99	87	75926	437	.48	Mostly blue sky above.
10:52:00	7.7	-47.5	.0034	.0110	99	92	68612	437	.59	
10:52:15	7.7	-47.6	.0028	.0049	99	66	61823	437	.48	
10:52:30	7.7	-47.7	.0006	.0020	100	60	24286	311	.63	At 38°17'N, 104°21'W. Wind [illegible] kt, heading 17[illegible]°. Much blue sky above;
10:52:45	7.7	-48.0	.0010	.0051	100	70	56429	311	.55	wispy cirrus filaments passing by.
10:53:00	7.7	-47.9	.0003	.0010	100	74	8005	250	.68	
10:53:15	7.7	-47.8	.0002	.0007	100	74	6045	311	.59	
10:53:30	7.7	-47.9	.0003	.0005	100	63	6742	230	.68	Mostly blue sky above.
10:53:45	7.7	47.8	.0007	.0009	100	52	13820	230	.68	
10:54:00	7.7	-47.8	.0014	.0016	100	42	32638	311	.51	
10:54:15	7.7	-47.8	.0019	.0000	100	35	10068	169	1.00	
10:54:30	7.7	-47.9	.0010	.0000	100	42	900	87	.91	
10:54:45	7.7	-47.6	.0003	.0001	100	44	2740	100	.92	
10:55:00	7.7	-47.7	.0000	.0005	100	33	11737	128	1.23	
10:55:15	7.7	-47.7	.0023	.0026	100	44	59401	311	.66	
10:55:30	7.6	-47.5	.0053	.0154	99	64	192417	437	.51	
10:55:45	7.7	-47.5	.0050	.0130	99	65	164007	437	.53	
10:56:00	7.7	-47.5	.0061	.0196	99	78	163465	437	.55	Back in heavier Cs for brief time [illegible] couple hundred feet above.
10:56:15	7.7	-47.5	.0042	.0137	99	87	86228	437	.56	
10:56:30	7.7	-47.5	.0036	.0173	98	109	63042	706	.54	Very thin Ci filam[illegible] blue sky above.
10:56:45	7.7	-47.4	.0015	.0034	99	96	20233	437	.55	
10:57:00	7.6	-47.5	.0013	.0040	100	98	22852	311	.56	
10:57:15	7.6	-47.4	.0007	.0027	100	65	31631	311	.56	At [illegible]'N, [illegible]'W. Wind [illegible] kt.
10:57:30	7.7	-47.4	.0002	.0006	100	44	15331	128	.83	
10:57:45	7.7	-47.5	.0000	.0024	99	65	28170	437	.53	
10:58:00	7.7	-47.7	.0003	.0004	100	51	7559	148	.82	
10:58:15	7.7	-47.4	.0003	.0000	100	33	400	47	1.00	
10:58:30	7.7	-47.4	.0001	0.0000	0	0	0	21	0.00	Can see ground below for first time. A big hole in the cloud cover. [illegible]
10:58:45	7.7	-47.5	.0002	.0000	100	33	400	47	1.00	above. Cloud in all quadrants, [illegible]

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29 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	D0 UM	NT N/M**3	LMAX UM	FF	
18:59:00	7.7	-47.4	.0002	.0002	100	35	5039	87	1.11	Ground has disappeared in the undercast.
18:59:15	7.7	-47.3	.0004	.0005	100	44	12129	169	.87	
18:59:30	7.6	-47.0	.0003	.0007	100	45	15363	148	.84	
18:59:45	7.6	-46.9	.0013	.0024	100	45	55462	189	.82	
19:00:00	7.6	-46.8	.0010	.0015	100	50	25960	250	.76	At 37°53'N, 104°29'W, 25,000 ft MSL.
19:00:15	7.7	-46.8	.0006	.0008	100	45	18034	169	.83	
19:00:30	7.7	-46.6	.0002	.0003	100	42	7361	148	.83	
19:00:45	7.7	-46.6	.0003	.0003	100	45	6807	169	.85	
19:01:00	7.7	-46.7	.0004	.0007	100	45	16469	189	.83	
19:01:15	7.7	-47.0	.0008	.0013	100	42	31091	189	.83	
19:01:30	7.7	-46.9	.0004	.0004	100	44	9944	250	.59	
19:01:45	7.7	-46.1	.0000	0.0000	0	0	0	14	0.00	
19:02:00	7.7	-45.9	.0001	0.0000	0	0	0	25	0.00	Can see down to ground again.
19:02:15	7.7	-45.5	.0001	0.0000	0	0	0	27	0.00	
19:02:30	7.7	-45.2	.0000	0.0000	0	0	0	18	0.00	
19:02:45	7.7	-45.8	0.0000	0.0000	0	0	0	0	0.00	
19:03:00	7.7	-44.5	.0000	0.0000	0	0	0	18	0.00	
19:03:15	7.7	-43.9	.0000	0.0000	0	0	0	19	0.00	
19:03:30	7.7	-43.7	.0000	0.0000	0	0	0	16	0.00	
19:03:45	7.7	-44.3	.0000	0.0000	0	0	0	12	0.00	
19:04:00	7.7	-44.5	.0000	0.0000	0	0	0	5	0.00	
19:04:15	7.7	-44.1	.0000	0.0000	0	0	0	9	0.00	
19:04:30	7.7	-44.3	.0000	0.0000	0	0	0	9	0.00	
19:04:45	7.7	-44.9	.0000	0.0000	0	0	0	19	0.00	
19:05:00	7.7	-45.0	.0000	0.0000	0	0	0	5	0.00	
19:05:15	7.7	-44.6	.0000	0.0000	0	0	0	12	0.00	Flying very near top of cirriform layer. Heavy Cs below, bright blue sky above,
19:05:30	7.7	-44.3	.0000	0.0000	0	0	0	21	0.00	
19:05:45	7.7	-43.8	.0001	0.0000	0	0	0	23	0.00	
19:06:00	7.7	-43.4	.0000	0.0000	0	0	0	16	0.00	
19:06:15	7.7	-43.4	.0000	0.0000	0	0	0	19	0.00	
19:06:30	7.7	-43.2	.0000	0.0000	0	0	0	16	0.00	
19:06:45	7.7	-43.2	.0000	0.0000	0	0	0	7	0.00	
19:07:00	7.7	-42.9	.0000	0.0000	0	0	0	23	0.00	
19:07:15	7.7	-42.3	.0000	0.0000	0	0	0	27	0.00	
19:07:30	7.7	-42.2	.0000	0.0000	0	0	0	27	0.00	
19:07:45	7.7	-42.5	.0000	0.0000	0	0	0	11	0.00	
19:08:00	7.7	-42.7	.0000	0.0000	0	0	0	25	0.00	
19:08:15	7.7	-42.4	.0000	0.0000	0	0	0	25	0.00	
19:08:30	7.7	-42.3	.0000	0.0000	0	0	0	23	0.00	
19:08:45	7.7	-42.3	.0001	.0000	100	33	298	47	1.00	
19:09:00	7.7	-42.3	.0000	0.0000	0	0	0	23	0.00	
19:09:15	7.7	-42.4	.0000	0.0000	0	0	0	23	0.00	
19:09:30	7.7	-42.3	.0001	0.0000	0	0	0	27	0.00	
19:09:45	7.7	-41.9	.0001	0.0000	0	0	0	27	0.00	
19:10:00	7.7	-42.4	.0001	0.0000	0	0	0	27	0.00	
19:10:15	7.7	-42.6	.0001	0.0000	0	0	0	27	0.00	
19:10:30	7.7	-42.8	.0002	0.0000	0	0	0	27	0.00	
19:10:45	7.7	-43.0	.0001	0.0000	0	0	0	27	0.00	
19:11:00	7.7	-42.8	.0001	0.0000	0	0	0	27	0.00	
19:11:15	7.7	-42.7	.0001	0.0000	0	0	0	27	0.00	
19:11:30	7.7	-42.9	.0002	0.0000	0	0	0	27	0.00	
19:11:45	7.7	-42.9	.0002	0.0000	0	0	0	27	0.00	
19:12:00	7.8	-43.0	.0001	0.0000	0	0	0	27	0.00	
19:12:15	7.8	-42.9	.0001	0.0000	0	0	0	25	0.00	
19:12:30	7.8	-43.1	.0002	0.0000	0	0	0	23	0.00	
19:12:45	7.8	-43.0	.0003	0.0000	0	0	0	27	0.00	

29 JAN 79 — 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
19:13:00	7.7	-42.7	.0002	0.0000	0	0	0	27	0.00	
19:13:15	7.7	-42.3	.0003	0.0000	0	0	0	27	0.00	
19:13:30	7.6	-42.2	.0002	0.0000	0	0	0	27	0.00	
19:13:45	7.7	-42.4	.0003	.0000	100	33	289	47	1.00	Skimming cloud tops through thin cirriform cloud.
19:14:00	7.7	-42.0	.0003	0.0000	0	0	0	27	0.00	
19:14:15	7.7	-41.4	.0002	0.0000	0	0	0	27	0.00	
19:14:30	7.7	-41.3	.0002	0.0000	0	0	0	27	0.00	
19:14:45	7.7	-41.6	.0003	0.0000	0	0	0	27	0.00	
19:15:00	7.6	-41.8	.0001	0.0000	0	0	0	27	0.00	
19:15:15	7.5	-41.8	.0001	0.0000	0	0	0	23	0.00	Beginning gradual descent to sample more cloud tops.
19:15:30	7.5	-41.6	.0003	0.0000	0	0	0	27	0.00	
19:15:45	7.3	-42.1	.0001	0.0000	0	0	0	27	0.00	
19:16:00	7.2	-42.2	.0001	0.0000	0	0	0	23	0.00	
19:16:15	7.1	-41.8	.0003	0.0000	0	0	0	27	0.00	
19:16:30	7.1	-41.9	.0003	0.0000	0	0	0	27	0.00	Heading 172°, wind 218°/44 kt. Much blue sky above. At level of cloud tops.
19:16:45	7.0	-41.2	.0003	0.0000	0	0	0	27	0.00	
19:17:00	7.0	-41.7	.0003	0.0000	0	0	0	27	0.00	
19:17:15	6.9	-42.3	.0002	0.0000	0	0	0	27	0.00	
19:17:30	6.9	-42.1	.0002	0.0000	0	0	0	27	0.00	
19:17:45	6.8	-41.7	.0003	0.0000	0	0	0	27	0.00	
19:18:00	6.6	-40.9	.0003	0.0000	0	0	0	27	0.00	
19:18:15	6.6	-39.9	.0003	0.0000	0	0	0	27	0.00	
19:18:30	6.6	-39.7	.0001	0.0000	0	0	0	23	0.00	
19:18:45	6.4	-39.4	.0000	.0000	100	42	120	67	1.00	Blue sky above. Seem to be in clear air, though Ci extends in all directions.
19:19:00	6.4	-38.7	.0000	0.0000	0	0	0	9	0.00	
19:19:15	6.3	-38.2	.0000	.0000	100	33	254	47	1.00	
19:19:30	6.3	-38.0	.0001	.0003	100	56	5927	169	.75	
19:19:45	6.3	-38.0	.0004	.0017	100	66	18232	311	.70	
19:20:00	6.3	-38.1	.0016	.0043	99	60	55846	250	.55	
19:20:15	6.3	-38.3	.0013	.0027	99	55	43251	230	.69	
19:20:30	6.3	-38.3	.0002	.0004	100	54	6480	209	.73	
19:20:45	6.2	-38.0	.0000	0.0000	0	0	0	7	0.00	Blue sky above. Leveling off at this altitude. Some cumuliform clouds in this area.
19:21:00	6.2	-37.8	.0000	0.0000	0	0	0	7	0.00	
19:21:15	6.2	-37.4	.0000	0.0000	0	0	0	7	0.00	
19:21:30	6.1	-37.3	.0000	0.0000	0	0	0	7	0.00	Ground dimly visible. Most clouds seem to be cirrocumulus (Cc) with relatively flat tops.
19:21:45	6.1	-37.4	.0000	0.0000	0	0	0	9	0.00	
19:22:00	6.1	-37.4	.0000	0.0000	0	0	0	11	0.00	
19:22:15	6.1	-36.7	.0000	0.0000	0	0	0	9	0.00	
19:22:30	6.1	-36.9	.0000	.0000	0	242	1	437	1.41	
19:22:45	6.2	-37.7	.0001	.0000	90	41	571	437	.29	
19:23:00	6.3	-38.3	.0001	0.0000	0	0	0	11	0.00	
19:23:15	6.4	-36.5	.0000	0.0000	0	0	0	9	0.00	
19:23:30	6.4	-36.4	.0000	0.0000	0	0	0	9	0.00	
19:23:45	6.4	-35.9	.0000	0.0000	0	0	0	9	0.00	
19:24:00	6.3	-35.5	.0000	0.0000	0	0	0	5	0.00	
19:24:15	6.2	-35.2	.0000	0.0000	0	0	0	18	0.00	
19:24:30	6.2	-36.5	.0007	.0003	100	33	7958	189	1.00	
19:24:45	6.2	-36.1	.0011	.0010	100	34	26119	189	1.06	
19:25:00	6.2	-36.2	.0003	.0001	100	69	217	209	1.21	
19:25:15	6.2	-35.5	.0000	.0000	0	242	0	437	1.41	
19:25:30	6.2	-35.5	0.0000	0.0000	0	0	0	0	0.00	
19:25:45	6.1	-36.4	.0030	.0010	99	54	15825	437	.58	Just skimming tops of Cc. Will go through some protuberances.
19:26:00	6.1	-35.4	.0007	.0003	100	63	3434	250	.61	
19:26:15	6.0	-36.1	.0030	.0010	100	48	18343	311	.54	
19:26:30	6.1	-36.2	.0004	.0001	100	40	2512	108	.83	
19:26:45	6.1	-36.5	.0019	.0009	99	57	12686	437	.52	

29 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	D0 UM	NT N/M**3	LMAX UM	FF
19:27:00	6.1	-36.7	.0042	.0031	99	54	48623	437	.48
19:27:15	6.1	-37.5	.0092	.0111	94	53	189452	706	.39
19:27:30	6.1	-38.0	.0036	.0071	96	60	92499	706	.48
19:27:45	6.1	-37.3	.0000	0.0000	0	0	0	9	0.00
19:28:00	6.2	-35.6	.0000	0.0000	0	0	0	3	0.00
19:28:15	6.2	-37.6	.0001	.0001	100	33	2042	87	1.21
19:28:30	6.2	-38.1	.0028	.0057	100	43	149818	169	.92
19:28:45	6.2	-38.1	.0060	.0101	100	45	234497	209	.86
19:29:00	6.2	-38.0	.0022	.0049	100	51	85531	230	.75
19:29:15	6.1	-38.2	.0023	.0074	100	58	101002	311	.71
19:29:30	6.1	-38.2	.0037	.0114	99	63	126214	437	.65
19:29:45	6.1	-37.9	.0174	.0265	95	51	439573	1011	.39
19:30:00	6.1	-36.7	.0010	.0003	100	36	6116	87	1.20
19:30:15	6.1	-36.0	0.0000	0.0000	0	0	0	0	0.00
19:30:30	6.1	-35.7	0.0000	0.0000	0	0	0	0	0.00
19:30:45	6.2	-35.7	0.0000	0.0000	0	0	0	0	0.00
19:31:00	6.2	-36.6	.0002	.0001	100	40	1318	148	1.18
19:31:15	6.2	-37.8	.0071	.0031	100	36	81303	230	.88
19:31:30	6.1	-37.8	.0121	.0047	100	35	101244	250	.89
19:31:45	6.1	-37.3	.0008	.0007	100	36	23454	148	1.01
19:32:00	6.0	-35.6	.0000	0.0000	0	0	0	5	0.00
19:32:15	6.0	-34.7	.0000	0.0000	0	0	0	2	0.00
19:32:30	6.0	-35.4	0.0000	0.0000	0	0	0	0	0.00
19:32:45	6.1	-36.2	.0000	0.0000	0	0	0	11	0.00
19:33:00	6.1	-36.9	.0013	.0004	100	35	8699	189	.96
19:33:15	6.1	-36.4	.0037	.0004	100	35	8340	189	.90
19:33:30	6.1	-36.2	.0073	.0030	88	41	45936	1011	.27
19:33:45	6.0	-36.7	.0013	.0003	100	31	6899	128	1.34
19:34:00	5.9	-36.3	.0000	.0000	85	43	399	437	.29
19:34:15	5.8	-35.5	.0000	0.0000	0	0	0	9	0.00
19:34:30	5.8	-34.9	.0000	0.0000	0	0	0	3	0.00
19:34:45	5.8	-35.0	.0000	0.0000	0	0	0	3	0.00
19:35:00	5.8	-34.5	.0000	0.0000	0	0	0	3	0.00
19:35:15	5.8	-34.8	.0000	0.0000	0	0	0	3	0.00
19:35:30	5.9	-35.8	.0052	.0017	100	30	38295	189	1.33
19:35:45	5.9	-36.5	.0027	.0016	99	43	31329	437	.56
19:36:00	5.8	-34.9	.0023	.0040	95	52	72695	706	.43
19:36:15	5.8	-34.4	.0022	.0025	99	49	44321	437	.54
19:36:30	5.8	-34.6	.0285	.0183	90	47	303945	1011	.27
19:36:45	5.9	-33.9	.0000	0.0000	0	0	0	19	0.00
19:37:00	5.9	-35.0	.0706	.0386	60	90	335823	2233	.08
19:37:15	5.9	-34.2	.0026	.0005	98	52	4994	437	.48
19:37:30	5.9	-34.0	0.0000	0.0000	0	0	0	0	0.00
19:37:45	5.8	-33.7	0.0000	0.0000	0	0	0	0	0.00
19:38:00	5.8	-33.1	.0000	0.0000	0	0	0	3	0.00
19:38:15	5.7	-31.6	.0000	0.0000	0	0	0	3	0.00
19:38:30	5.5	-32.0	.0000	0.0000	0	0	0	5	0.00
19:38:45	5.4	-32.4	.0000	0.0000	0	0	0	9	0.00
19:39:00	5.4	-32.7	.0007	.0018	89	77	15418	706	.33
19:39:15	5.4	-32.9	0.0000	0.0000	0	0	0	0	0.00
19:39:30	5.4	-32.8	.0000	0.0000	0	0	0	21	0.00
19:39:45	5.4	-32.9	.0002	.0004	99	52	6196	437	.69
19:40:00	5.4	-32.6	.0000	.0001	100	55	1078	148	.73
19:40:15	5.4	-32.4	.0001	.0000	100	51	630	169	.61
19:40:30	5.4	-32.8	.0003	.0013	99	49	26826	437	.71
19:40:45	5.5	-33.6	.0059	.0135	95	53	220463	706	.41

[illegible]

[illegible] through as many of these [illegible]
[illegible] off the cirrostratus (Cs).

[illegible]

At [illegible] kt.

[illegible] there is a solid undercast.

[illegible] several of these in [illegible]

At [illegible] the cloud tops.
[illegible]

29 JAN 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	D0 UM	NT N/M**3	LMAX UM	FF
19:41:00	5.4	-33.1	.0001	.0002	92	81	2676	706	.28
19:41:15	5.4	-32.4	0.0000	0.0000	0	0	0	0	0.00
19:41:30	5.4	-32.4	0.0000	.0000	100	23	0	26	0.00
19:41:45	5.4	-32.1	0.0000	.0000	100	23	0	26	0.00
19:42:00	5.4	-32.4	0.0000	.0001	100	23	0	26	0.00
19:42:15	5.3	-32.4	0.0000	.0001	100	25	949	47	2.88
19:42:30	5.3	-32.0	.0001	.0001	100	41	1747	108	1.00
19:42:45	5.3	-32.0	.0002	.0004	100	49	6326	230	.69
19:43:00	5.3	-32.0	.0013	.0036	100	62	44086	311	.63
19:43:15	5.3	-32.0	.0015	.0033	100	62	43025	311	.58
19:43:30	5.3	-31.9	.0014	.0046	99	78	35979	437	.58
19:43:45	5.2	-31.3	.0014	.0039	99	73	37674	437	.53
19:44:00	5.2	-31.3	.0003	.0009	100	72	5783	311	.68
19:44:15	5.2	-31.1	.0008	.0025	99	77	22522	437	.55
19:44:30	5.1	-30.3	.0012	.0044	100	77	37304	311	.58
19:44:45	5.1	-30.2	.0015	.0078	99	108	25614	437	.66
19:45:00	5.1	-30.4	.0002	.0002	100	45	4571	169	.76
19:45:15	5.1	-30.3	.0010	.0043	100	57	66292	311	.60
19:45:30	5.2	-30.7	.0005	.0010	100	58	15069	311	.52
19:45:45	5.2	-30.8	.0011	.0010	100	38	31835	128	.94
19:46:00	5.2	-31.0	.0028	.0039	100	44	91381	311	.70
19:46:15	5.3	-31.6	.0025	.0041	100	49	81552	250	.79
19:46:30	5.3	-31.9	.0037	.0091	100	53	147348	311	.75
19:46:45	5.3	-31.8	.0040	.0113	100	52	193081	311	.73
19:47:00	5.3	-31.8	.0038	.0086	100	53	141241	311	.68
19:47:15	5.3	-31.6	.0033	.0045	100	44	104983	209	.84
19:47:30	5.2	-31.3	.0030	.0047	100	46	103025	209	.83
19:47:45	5.2	-31.4	.0040	.0125	100	57	181325	311	.69
19:48:00	5.2	-31.0	.0036	.0103	99	61	122779	437	.66
19:48:15	5.2	-31.3	.0028	.0076	100	55	118317	250	.75
19:48:30	5.2	-31.4	.0028	.0116	100	72	101147	311	.65
19:48:45	5.2	-31.2	.0017	.0052	100	61	63525	311	.66
19:49:00	5.2	-30.8	.0009	.0012	100	48	24230	230	.73
19:49:15	5.2	-31.0	.0018	.0061	99	79	45129	437	.57
19:49:30	5.2	-30.4	.0022	.0095	99	80	66228	437	.59

Many convective cell [illegible] the flat tops.

Can see through to ground [illegible] much lower here than they were in Colorado earlier.

Continue moving in and out of wispy filaments near cloud tops.

At 35°37'N, 105°1.'W [illegible] were tops of ice clouds.

Little demarcation between the thin cloud the aircraft is in and the blue sky above.

Appendix C

2 February 1979 Data Tabulations

Tabulations follow the format described in Appendix A.

02 FEB 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF
20:55:00	9.1	-38.7	.0016	.0038	99	69	35385	437	.66
20:55:15	9.1	-38.5	.0019	.0042	100	63	52414	311	.65
20:55:30	9.1	-38.4	.0025	.0050	99	69	58656	437	.56
20:55:45	9.1	-38.4	.0016	.0052	99	77	39564	437	.61
20:56:00	9.1	-38.5	.0013	.0044	100	71	46072	311	.57
20:56:15	9.1	-38.6	.0013	.0037	100	70	34446	311	.63
20:56:30	9.1	-38.8	.0020	.0043	99	84	32615	437	.56
20:56:45	9.1	-38.8	.0014	.0052	99	72	45554	437	.63
20:57:00	9.1	-38.9	.0028	.0065	99	61	71805	437	.59
20:57:15	9.1	-38.9	.0032	.0075	100	58	109065	250	.71
20:57:30	9.1	-38.8	.0042	.0081	100	55	130812	311	.60
20:57:45	9.1	-38.8	.0012	.0037	100	62	48004	311	.62
20:58:00	9.1	-38.8	.0012	.0037	100	61	43706	311	.69
20:58:15	9.1	-38.9	.0014	.0039	99	64	45731	437	.70
20:58:30	9.1	-38.9	.0013	.0038	99	67	35629	437	.66
20:58:45	9.1	-38.9	.0010	.0032	99	73	25404	437	.63
20:59:00	9.1	-39.1	.0010	.0029	99	74	21207	437	.63
20:59:15	9.1	-39.0	.0012	.0029	99	61	37282	437	.64
20:59:30	9.1	-39.2	.0007	.0020	100	67	20564	311	.58
20:59:45	9.1	-39.4	.0008	.0020	100	63	26615	311	.62
21:00:00	9.2	-39.5	.0007	.0019	100	62	23878	311	.61
21:00:15	9.2	-39.5	.0006	.0021	100	64	22698	250	.70
21:00:30	9.2	-39.6	.0007	.0015	100	62	20158	311	.55
21:00:45	9.2	-39.6	.0011	.0026	100	56	34251	311	.69
21:01:00	9.2	-39.7	.0008	.0021	100	56	30916	311	.65
21:01:15	9.2	-39.7	.0007	.0015	100	50	26137	189	.84
21:01:30	9.2	-39.7	.0010	.0020	100	53	33823	311	.61
21:01:45	9.2	-39.9	.0013	.0030	100	53	48964	230	.77
21:02:00	9.2	-40.0	.0023	.0050	100	55	74446	311	.65
21:02:15	9.2	-40.0	.0014	.0034	99	56	50647	437	.72
21:02:30	9.2	-40.1	.0012	.0032	100	61	38680	311	.65
21:02:45	9.2	-40.2	.0009	.0027	100	67	25197	311	.70
21:03:00	9.2	-40.2	.0009	.0024	100	69	21136	311	.64
21:03:15	9.2	-40.4	.0009	.0032	99	71	27907	437	.63
21:03:30	9.2	-40.4	.0016	.0050	100	75	38795	311	.62
21:03:45	9.3	-40.5	.0015	.0042	99	82	42356	437	.59
21:04:00	9.3	-40.6	.0009	.0041	100	93	18877	311	.63
21:04:15	9.3	-40.8	.0006	.0026	98	101	8932	437	.68
21:04:30	9.3	-40.9	.0005	.0025	82	111	8412	706	.50
21:04:45	9.3	-41.1	.0006	.0014	98	64	15811	437	.55
21:05:00	9.4	-41.3	.0009	.0026	99	60	31249	437	.56
21:05:15	9.4	-41.5	.0008	.0025	99	115	20399	437	.41
21:05:30	9.4	-41.8	.0006	.0025	67	130	8733	706	.40
21:05:45	9.5	-42.0	.0007	.0023	71	130	4310	706	.55
21:06:00	9.5	-42.2	.0005	.0018	75	125	5010	706	.48
21:06:15	9.5	-42.3	.0011	.0042	75	27	10472	706	.54
21:06:30	9.5	-42.4	.0019	.0075	97	114	19165	437	.69
21:06:45	9.5	-42.5	.0021	.0091	99	106	24996	437	.73
21:07:00	9.6	-42.7	.0020	.0094	100	87	49397	311	.65
21:07:15	9.6	-43.0	.0014	.0048	100	63	54647	311	.67
21:07:30	9.6	-43.1	.0022	.0068	100	59	88458	311	.55
21:07:45	9.6	-43.0	.0031	.0099	99	62	124084	437	.52
21:08:00	9.6	-42.9	.0033	.0091	99	62	118485	437	.56
21:08:15	9.6	-43.[illegible]	.0034	.0100	99	64	113042	437	.5[illegible]
21:08:30	9.7	-43.1	.0049	.0095	100	54	143528	311	.54
21:08:45	9.6	-43.1	.0049	.0095	99	52	156372	437	.53

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		02 FEB 79		15 SECOND AVERAGE						
START TIME	HLT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
21:09:00	9.6	-43.1	.0044	.0082	100	50	144858	311	.64	
21:09:15	9.6	-43.2	.0029	.0073	100	54	112604	311	.57	
21:09:30	9.7	-43.3	.0024	.0063	100	56	96668	311	.59	Must be either [illegible]
21:09:45	9.6	-43.1	.0029	.0077	100	57	116371	311	.58	[illegible]
21:10:00	9.6	-43.0	.0033	.0066	99	54	106769	437	.63	
21:10:15	9.6	-43.0	.0046	.0066	100	47	130857	311	.68	
21:10:30	9.6	-43.1	.0020	.0033	100	42	77347	230	.84	
21:10:45	9.6	-43.2	.0019	.0028	100	44	63888	189	.86	
21:11:00	9.6	-43.1	.0021	.0042	100	46	88330	311	.70	
21:11:15	9.6	-43.1	.0021	.0035	100	38	97716	189	.95	Near [illegible]
21:11:30	9.6	-43.1	.0016	.0034	100	48	69152	189	.84	At [illegible]
21:11:45	9.6	-43.1	.0011	.0030	100	53	51433	230	.78	
21:12:00	9.6	-43.1	.0028	.0043	100	45	98741	189	.86	
21:12:15	9.6	-43.1	.0019	.0037	100	46	76121	169	.89	
21:12:30	9.6	-42.9	.0038	.0050	100	36	138202	169	1.05	Seem to have [illegible]
21:12:45	9.6	-42.9	.0045	.0061	100	39	154226	169	1.01	
21:13:00	9.6	-42.9	.0022	.0029	100	39	69526	209	.88	
21:13:15	9.6	-42.9	.0002	.0004	100	75	3739	311	.46	
21:13:30	9.6	-43.0	.0002	.0003	100	61	3163	230	.69	
21:13:45	9.6	-43.1	.0002	.0004	100	59	5082	189	.80	In thin [illegible]
21:14:00	9.6	-43.2	.0003	.0004	100	64	3491	230	.78	all directions [illegible]
21:14:15	9.6	-43.2	.0000	.0007	100	63	6853	250	.65	
21:14:30	9.6	-43.2	.0009	.0050	100	84	29892	311	.66	
21:14:45	9.6	-43.4	.0018	.0082	100	81	48448	311	.73	
21:15:00	9.6	-43.7	.0001	.0015	100	73	12738	311	.64	A good sampling area [illegible]
21:15:15	9.6	-43.7	.0002	.0016	100	68	16880	230	.69	[illegible]
21:15:30	9.6	-43.7	.0001	.0014	100	64	15457	250	.64	
21:15:45	9.6	-43.7	.0008	.0024	100	47	44302	250	.63	
21:16:00	9.6	-43.8	.0010	.0038	100	54	55348	250	.68	In nearly clear [illegible]
21:16:15	9.6	-44.0	.0000	.0017	100	68	15193	250	.64	
21:16:30	9.6	-44.1	0.0000	.0018	100	57	19164	311	.66	
21:16:45	9.6	-44.1	0.0000	.0022	100	63	21188	250	.75	
21:17:00	9.6	-44.0	0.0000	.0037	100	58	40466	250	.78	
21:17:15	9.6	-43.7	.0000	.0030	100	61	30430	250	.86	
21:17:30	9.6	-43.2	0.0000	.0029	100	57	34394	230	.86	
21:17:45	9.6	-42.8	.0000	.0036	100	60	38991	250	.81	
21:18:00	9.6	-42.7	0.0000	.0033	100	56	40331	250	.82	
21:18:15	9.6	-43.0	.0000	.0029	100	59	37576	250	.72	
21:18:30	9.6	43.4	0.0000	.0028	100	57	36744	230	.78	
21:18:45	9.6	-43.5	.0000	.0019	100	56	29178	209	.81	
21:19:00	9.6	-43.6	0.0000	.0016	100	55	23279	209	.83	[illegible]
21:19:15	9.6	-43.7	.0000	.0010	100	56	15828	189	.81	[illegible]
21:19:30	9.6	-43.7	0.0000	.0006	100	51	9318	148	.92	
21:19:45	9.6	43.7	0.0000	.0009	100	55	16703	189	.77	
[illegible]	9.6	43.7	.0000	.0005	100	54	8012	169	.87	
[illegible]	9.6	43.7	.0001	.0006	100	52	9585	169	.86	
[illegible]	9.6	43.7	.0003	.0004	100	48	7241	128	.94	
21:20:45	9.6	43.7	.0004	.0004	100	38	8363	148	1.02	
[illegible]	[illegible]	43.7	.0001	.0002	100	42	5093	128	.99	
[illegible]	[illegible]	43.8	0.0000	.0001	100	51	2681	148	.82	[illegible]
[illegible]	[illegible]	43.9	0.0000	.0004	100	54	6360	169	.84	
[illegible]	[illegible]	43.9	0.0000	.0003	100	50	5459	169	.75	
[illegible]	[illegible]	43.9	0.0000	.0001	100	50	1150	128	.89	
[illegible]	[illegible]	44.0	0.0000	.0001	100	52	1071	108	.86	
[illegible]	[illegible]	43.9	0.0000	.0000	100	42	615	108	.80	[illegible]
[illegible]	[illegible]	43.9	0.0000	.0000	100	49	[illegible]	[illegible]	.97	

02 FEB 79 — 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
21:23:00	9.6	-44.0	0.0000	.0002	100	52	3581	108	.96	Doesn't seem to be any cirrus here at all. There are some Cu below, but
21:23:15	9.6	-44.0	0.0000	.0005	100	53	7372	128	.89	not an undercast.
21:23:30	9.6	-44.1	0.0000	.0008	100	52	11132	169	.91	
21:23:45	9.6	-44.1	.0000	.0006	100	55	7776	169	.92	
21:24:00	9.6	-43.9	0.0000	.0007	100	54	9776	169	.92	Only getting very small particles now.
21:24:15	9.6	-43.9	0.0000	.0006	100	55	7937	128	.91	
21:24:30	9.6	-43.7	0.0000	.0011	100	53	15405	169	.93	
21:24:45	9.6	-43.6	0.0000	.0007	100	57	8640	148	.92	
21:25:00	9.6	-43.6	0.0000	.0007	100	53	10525	128	.92	
21:25:15	9.6	-43.7	0.0000	.0013	100	55	17219	209	.85	
21:25:30	9.6	-43.7	0.0000	.0011	100	54	13853	189	.92	
21:25:45	9.6	-43.6	0.0000	.0015	100	54	22616	189	.84	
21:26:00	9.6	-43.8	0.0000	.0014	100	53	20339	209	.86	
21:26:15	9.6	-43.8	0.0000	.0011	100	57	17001	189	.78	
21:26:30	9.6	-43.9	0.0000	.0016	100	55	21051	209	.86	
21:26:45	9.6	-43.9	.0003	.0008	100	58	10555	169	.86	
21:27:00	9.6	-44.0	.0006	.0006	100	55	8590	169	.85	
21:27:15	9.6	-44.1	.0006	.0005	100	52	7769	169	.83	
21:27:30	9.6	-44.1	.0005	.0005	100	54	8864	230	.73	
21:27:45	9.6	-43.9	.0005	.0005	100	53	8920	209	.79	
21:28:00	9.6	-43.6	.0004	.0007	100	51	10938	189	.84	Getting small particles. Still turning to right.
21:28:15	9.6	-43.3	.0005	.0004	100	51	9245	169	.76	
21:28:30	9.6	-43.1	.0005	.0003	100	48	5938	148	.91	
21:28:45	9.6	-43.0	.0004	.0003	100	47	6458	128	.96	
21:29:00	9.6	-43.3	.0003	.0001	100	47	2846	148	.83	
21:29:15	9.6	-43.5	.0004	.0003	100	53	5143	169	.75	
21:29:30	9.6	-43.6	.0005	.0002	100	50	4513	169	.76	
21:29:45	9.6	-43.7	.0004	.0002	100	51	3479	169	.81	Heading toward Cs band. At 34° 44'N, 105° 23'W. Very thin cirriform clouds.
21:30:00	9.6	-43.7	.0002	.0003	100	48	6403	148	.79	
21:30:15	9.6	-43.8	.0000	.0002	100	56	2163	148	.88	
21:30:30	9.6	-43.7	.0002	.0002	100	50	3637	128	.86	
21:30:45	9.6	-43.6	.0002	.0002	100	50	2545	148	.96	
21:31:00	9.6	-43.2	.0001	.0000	100	50	506	108	1.16	In very thin Ci. A darker, heavier cirriform band is 5-10 miles ahead.
21:31:15	9.6	-43.2	.0002	.0000	100	44	1041	87	.97	Blue sky is above it.
21:31:30	9.6	-43.6	.0001	.0000	100	38	939	128	.72	
21:31:45	9.6	-44.0	.0001	.0000	100	51	510	128	.73	
21:32:00	9.6	-44.1	0.0000	.0000	100	51	100	87	1.00	
21:32:15	9.6	-43.9	0.0000	0.0000	0	0	0	0	0.00	Heading 147°, wind 244°/171 kt.
21:32:30	9.6	-43.0	0.0000	0.0000	0	0	0	0	0.00	
21:32:45	9.6	-43.2	0.0000	0.0000	0	0	0	0	0.00	
21:33:00	9.6	-43.8	0.0000	0.0000	0	0	0	0	0.00	
21:33:15	9.6	-43.4	0.0000	0.0000	0	0	0	0	0.00	Will try to fly parallel to cirriform band.
21:33:30	9.6	-42.9	0.0000	0.0000	0	0	0	0	0.00	
21:33:45	9.6	-42.3	0.0000	0.0000	0	0	0	0	0.00	
21:34:00	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	
21:34:15	9.6	-42.3	0.0000	0.0000	0	0	0	0	0.00	
21:34:30	9.6	-42.8	0.0000	0.0000	0	0	0	0	0.00	
21:34:45	9.6	-43.0	0.0000	0.0000	0	0	0	0	0.00	
21:35:00	9.6	-43.1	0.0000	0.0000	0	0	0	0	0.00	
21:35:15	9.6	-43.1	0.0000	0.0000	0	0	0	0	0.00	Definite cirriform layer off right wing Bright blue sky above it.
21:35:30	9.6	-43.0	0.0000	0.0000	0	0	0	0	0.00	
21:35:45	9.6	-42.8	0.0000	0.0000	0	0	0	0	0.00	
21:36:00	9.6	-42.7	0.0000	0.0000	0	0	0	0	0.00	Should be a good period for sampling thin Ci, but it must be farther than
21:36:15	9.6	-42.7	0.0000	.0000	100	62	144	128	.93	it looks. Heading 012°.
21:36:30	9.6	-42.8	0.0000	.0000	100	65	48	128	1.00	
21:36:45	9.6	-43.3	0.0000	.0000	100	42	158	67	1.00	

02 FEB 79 — 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DV UM	NT N/M**3	LMAX UM	FF	
21:37:00	9.6	-43.7	0.0000	0.0000	0	0	0	0	0.00	
21:37:15	9.6	-43.4	0.0000	0.0000	0	0	0	0	0.00	At 34°44'N, 104°42'W. GS [illegible] kt.
21:37:30	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:37:45	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:38:00	9.6	-42.9	0.0000	0.0000	0	0	0	0	0.00	Thin cirrus off to our left. Cu below. Have been making several turns
21:38:15	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	to try to stay close to the high cloud. Visibility is 50+ miles.
21:38:30	9.6	-41.8	0.0000	0.0000	0	0	0	0	0.00	
21:38:45	9.6	-41.8	0.0000	0.0000	0	0	0	0	0.00	
21:39:00	9.6	-41.8	0.0000	0.0000	0	0	0	0	0.00	
21:39:15	9.6	-41.9	0.0000	.0000	100	33	355	47	1.00	
21:39:30	9.6	-41.9	0.0000	0.0000	0	0	0	0	0.00	
21:39:45	9.6	-41.9	0.0000	0.0000	0	0	0	0	0.00	
21:40:00	9.6	-41.9	0.0000	0.0000	0	0	0	0	0.00	Moving parallel to Ci band. Heading 229°.
21:40:15	9.6	-42.0	0.0000	0.0000	0	0	0	0	0.00	
21:40:30	9.6	-42.0	0.0000	0.0000	0	0	0	0	0.00	
21:40:45	9.6	-42.0	0.0000	0.0000	0	0	0	0	0.00	
21:41:00	9.6	-42.0	0.0000	0.0000	0	0	0	0	0.00	Still about parallel to the band. Heading 218°.
21:41:15	9.6	-42.0	0.0000	.0000	100	55	171	108	.98	
21:41:30	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	
21:41:45	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	
21:42:00	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	Moving closer to the Ci band. Seem to be above some cirrus, but it's thin
21:42:15	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	*and hard to judge.*
21:42:30	9.6	-42.1	0.0000	0.0000	0	0	0	0	0.00	
21:42:45	9.6	-42.2	0.0000	0.0000	0	0	0	0	0.00	
21:43:00	9.6	-42.3	0.0000	0.0000	0	0	0	0	0.00	Flying parallel to cirriform band.
21:43:15	9.6	-42.3	0.0000	.0000	100	51	99	87	1.00	
21:43:30	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:43:45	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:44:00	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	Heading 230°. Wind 245°/167 kt.
21:44:15	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:44:30	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:44:45	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:45:00	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	Very near top of most cirrus, but most of it is below left wing.
21:45:15	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	Considerable Cu below, but not an undercast.
21:45:30	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:45:45	9.6	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:46:00	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	Must be out of all cloud filaments. Only blue sky above.
21:46:15	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:46:30	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	Wind 246°/171 kt. GS 80 kt! Heading 230°. At 34°44'N, 104° 52'W.
21:46:45	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:47:00	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:47:15	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:47:30	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:47:45	9.6	-42.3	0.0000	.0000	100	42	167	67	1.00	
21:48:00	9.6	-42.3	0.0000	0.0000	0	0	0	0	0.00	
21:48:15	9.6	-42.4	0.0000	.0000	100	42	169	67	1.00	Probably above all Ci.
21:48:30	9.6	-42.5	0.0000	.0000	100	51	101	87	1.00	
21:48:45	9.6	-42.4	0.0000	0.0000	0	0	0	0	0.00	
21:49:00	9.6	-42.6	0.0000	0.0000	0	0	0	0	0.00	
21:49:15	9.6	-42.7	0.0000	0.0000	0	0	0	0	0.00	
21:49:30	9.6	-42.8	0.0000	0.0000	0	0	0	0	0.00	
21:49:45	9.6	-42.8	0.0000	0.0000	0	0	0	0	0.00	
21:50:00	9.6	-42.8	0.0000	0.0000	0	0	0	0	0.00	Heading 230°. No particle counts recently.
21:50:15	9.6	-42.9	0.0000	0.0000	0	0	0	0	0.00	
21:50:30	9.6	-43.0	0.0000	0.0000	0	0	0	0	0.00	
21:50:45	9.6	-43.2	0.0000	0.0000	0	0	0	0	0.00	

02 FEB 79 — 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
21:51:00	9.6	43.4	0.0000	0.0000	0	0	0	0	0.00	
21:51:15	9.6	-43.4	0.0000	0.0000	0	0	0	0	0.00	
21:51:30	9.6	43.4	0.0000	0.0000	0	0	0	0	0.00	
21:51:45	9.6	-43.5	0.0000	0.0000	0	0	0	0	0.00	
21:52:00	9.6	43.5	0.0000	0.0000	0	0	0	0	0.00	
21:52:15	9.6	43.5	0.0000	0.0000	0	0	0	0	0.00	
21:52:30	9.6	-43.6	0.0000	0.0000	0	0	0	0	0.00	
21:52:45	9.6	-43.6	0.0000	0.0000	0	0	0	0	0.00	Beginning turn to left to get closer to Ci band.
21:53:00	9.6	-43.6	0.0000	0.0000	0	0	0	0	0.00	
21:53:15	9.5	-43.3	0.0000	0.0000	0	0	0	0	0.00	
21:53:30	9.5	43.1	0.0000	0.0000	0	0	0	0	0.00	
21:53:45	9.5	-42.9	0.0000	0.0000	0	0	0	0	0.00	
21:54:00	9.5	-42.8	0.0000	0.0000	0	0	0	0	0.00	
21:54:15	9.4	-42.6	0.0000	0.0000	0	0	0	0	0.00	
21:54:30	9.4	-42.5	0.0000	0.0000	0	0	0	0	0.00	
21:54:45	9.4	-42.3	0.0000	0.0000	0	0	0	0	0.00	
21:55:00	9.4	-42.2	0.0000	0.0000	0	0	0	0	0.00	
21:55:15	9.4	-42.0	0.0000	0.0000	0	0	0	0	0.00	
21:55:30	9.4	-42.0	0.0000	0.0000	0	0	0	0	0.00	Descending. Will go back parallel to the band
21:55:45	9.4	-42.0	0.0000	0.0000	0	0	0	0	0.00	
21:56:00	9.3	-41.7	0.0000	0.0000	0	0	0	0	0.00	
21:56:15	9.3	-41.3	0.0000	.0000	100	53	474	189	.55	
21:56:30	9.2	-41.0	0.0000	0.0000	0	0	0	0	0.00	At 34° 38'N, 104° 39'W.
21:56:45	9.2	-40.7	0.0000	.0000	100	42	166	67	1.00	
21:57:00	9.2	-40.5	.0002	.0004	100	38	10104	169	.96	
21:57:15	9.1	40.1	.0003	.0004	100	44	8263	189	.87	Now in very thin cirrus. Slant visibility 30-40 mi., but can see cloud
21:57:30	9.1	-39.7	.0000	.0001	100	38	1870	128	.75	filaments going by.
21:57:45	9.0	39.3	.0017	.0033	100	45	76468	230	.80	
21:58:00	9.0	39.1	.0026	.0058	100	52	98936	250	.75	
21:58:15	9.0	-39.3	.0007	.0012	100	42	31818	209	.77	
21:58:30	9.0	39.4	.0002	.0012	100	54	17681	189	.78	
21:58:45	9.0	-39.5	.0003	.0009	100	75	6341	311	.67	
21:59:00	9.0	-39.5	.0000	.0003	100	98	1709	311	.56	Good thin sampling conditions. Visibility good, but can see thin
21:59:15	9.0	39.6	.0002	.0008	100	92	3967	311	.60	filaments moving past aircraft.
21:59:30	9.0	39.6	.0001	.0005	100	81	2642	311	.69	
21:59:45	9.0	-39.5	.0009	.0027	100	69	25388	311	.68	
22:00:00	9.1	39.4	.0008	.0030	100	63	34912	311	.65	Approximately in middle of Ci layer. At 34° 40'N, 104° 32'W
[illegible]	9.1	-39.5	.0010	.0039	100	72	37271	311	.58	Can see thin cloud filaments both above and below.
[illegible]	[illegible]	39.3	.0010	.0042	100	68	41138	311	.64	
[illegible]	[illegible]	39.[illegible]	.0022	.0078	100	73	63010	311	.65	
[illegible]	9.0	38.7	.0020	.0071	100	63	82212	311	.69	
[illegible]	9.0	-39.6	.0056	.0179	100	57	254762	311	.60	
[illegible]	[illegible]	39.2	.0045	.0114	100	52	188201	311	.73	
[illegible]	9.0	-39.[illegible]	.0020	.0058	100	57	83459	311	.71	
[illegible]	[illegible]	38.9	.000[illegible]	.0026	100	66	25899	311	.73	Now into moderately heavy Cs layer. Wind 247°/100 kt.
[illegible]	9.0	38.8	.0010	.0024	100	52	41048	209	.83	
22:02:30	9.0	38.7	.0008	.0020	100	49	40159	230	.80	
22:02:45	[illegible]	38.[illegible]	.0011	.0032	100	55	49133	209	.80	
22:03:00	[illegible]	-38.7	.0014	.0044	100	64	48186	250	.74	Heavy Cs. Visibility much reduced.
22:03:15	[illegible]	38.7	.0019	.0060	100	69	54567	311	.71	
[illegible]	[illegible]	38.7	.0018	.0066	100	64	76737	311	.65	
[illegible]	9.0	38.6	.0026	.0083	100	61	103531	311	.69	
22:04:00	9.0	38.6	.0027	.0095	100	60	122995	311	.64	Heading 227°. Ground only dimly visible. [illegible]
22:04:15	[illegible]	38.5	.0027	.0093	100	66	91360	311	.71	bright through foggy Ci layer
22:04:30	[illegible]	38.5	.0027	.0061	100	58	83137	250	.71	
22:04:45	[illegible]	39.4	.0031	.0056	100	49	113487	[illegible]	.78	

02 FEB 79 — 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
22:05:00	9.0	-38.4	.0038	.0043	100	47	85823	311	.72	
22:05:15	8.9	-38.3	.0022	.0047	100	48	90452	311	.63	
22:05:30	8.9	-38.3	.0023	.0052	100	52	87356	311	.55	
22:05:45	8.9	-38.2	.0020	.0050	100	51	88475	311	.60	
22:06:00	8.9	-38.2	.0023	.0053	100	53	88701	209	.78	
22:06:15	8.9	-38.1	.0013	.0042	100	52	71515	230	.80	
22:06:30	8.9	-38.2	.0016	.0065	100	52	113918	311	.74	
22:06:45	8.9	-38.3	.0022	.0072	100	55	111666	311	.75	Heavy Cs. Wind 245°/153 kt. Heading 220°.
22:07:00	9.0	-38.3	.0018	.0060	100	53	100552	311	.72	
22:07:15	9.0	-38.2	.0024	.0079	100	52	135020	311	.68	
22:07:30	9.0	-38.2	.0034	.0106	100	55	154503	311	.72	
22:07:45	9.0	-38.2	.0027	.0104	100	57	145266	311	.71	
22:08:00	9.0	-38.3	.0021	.0076	100	53	120346	250	.73	Sun is brighter than before.
22:08:15	9.0	-38.4	.0016	.0078	100	59	92001	250	.78	
22:08:30	8.9	-38.4	.0022	.0100	100	63	103085	311	.71	
22:08:45	8.9	-38.3	.0026	.0117	100	65	119080	311	.70	
22:09:00	8.9	-38.4	.0016	.0077	100	64	80382	311	.68	
22:09:15	8.9	-38.1	.0021	.0088	100	65	88455	311	.67	
22:09:30	8.9	-38.2	.0017	.0072	100	65	69232	311	.66	
22:09:45	9.0	-38.5	.0006	.0038	100	67	34769	311	.69	
22:10:00	9.0	-38.5	.0005	.0031	100	61	32372	311	.68	
22:10:15	9.0	-38.5	.0011	.0037	100	61	47157	250	.68	
22:10:30	9.0	-38.5	.0007	.0029	100	61	31729	311	.70	
22:10:45	9.0	-38.6	.0011	.0038	100	59	53609	230	.73	
22:11:00	8.9	-38.5	.0009	.0020	100	50	35384	230	.82	Still heavy Cs. but visibility has improved slightly. Seem to be in middle of at least a thin overcast.
22:11:15	9.0	-38.3	.0004	.0010	100	54	15679	209	.79	
22:11:30	9.0	-38.4	.0009	.0021	100	53	33848	250	.75	
22:11:45	9.0	-38.6	.0013	.0032	100	51	55464	230	.80	
22:12:00	9.0	-38.7	.0007	.0016	100	54	24736	189	.81	
22:12:15	9.0	-38.6	.0014	.0043	100	63	48925	311	.65	
22:12:30	9.0	-38.4	.0002	.0007	100	53	11183	189	.82	
22:12:45	9.0	-38.7	.0013	.0038	100	58	52580	311	.70	
22:13:00	9.0	-39.1	.0013	.0044	100	66	44984	311	.67	
22:13:15	9.0	-38.8	.0009	.0032	100	70	28209	311	.69	
22:13:30	9.0	-38.7	.0017	.0063	100	64	70661	311	.69	Still heavy Cs. Heading 240°. GS 108 kt.
22:13:45	9.0	-38.5	.0002	.0008	100	68	6176	250	.78	
22:14:00	9.0	-38.6	.0003	.0013	100	63	13739	230	.75	
22:14:15	9.0	-38.7	.0013	.0048	100	65	52482	311	.68	
22:14:30	9.0	-38.8	.0007	.0030	100	74	23879	311	.68	
22:14:45	9.0	-38.9	.0012	.0048	100	71	44671	311	.66	
22:15:00	9.0	-38.8	.0017	.0059	100	65	59791	311	.70	Very milky, heavy Cs. Can see through to ground.
22:15:15	9.0	-38.7	.0016	.0056	100	61	63875	311	.74	
22:15:30	9.0	-38.6	.0021	.0074	100	59	95173	311	.69	
22:15:45	9.0	-38.6	.0023	.0085	100	69	79900	311	.65	
22:16:00	9.0	-38.5	.0016	.0064	100	72	53167	311	.69	
22:16:15	9.0	-38.5	.0020	.0073	100	74	57212	311	.62	
22:16:30	9.0	-38.4	.0016	.0063	100	72	49088	311	.69	
22:16:45	9.0	-38.6	.0008	.0033	100	74	24831	311	.69	
22:17:00	9.0	-39.0	.0014	.0051	100	73	41346	311	.68	
22:17:15	9.0	-38.7	.0016	.0062	100	70	50924	311	.69	
22:17:30	9.0	-38.5	.0006	.0023	100	85	12112	311	.70	
22:17:45	9.0	-38.4	.0015	.0051	100	69	52743	311	.59	
22:18:00	9.0	-38.4	.0024	.0074	100	55	113149	311	.70	
22:18:15	9.0	-38.6	.0040	.0087	100	52	150712	311	.67	
22:18:30	9.0	-38.4	.0028	.0046	100	59	66732	250	.70	
22:18:45	9.0	-38.2	.0036	.0018	100	33	41839	250	.78	

02 FEB 79 15 SECOND AVERAGE

START TIME	ALT KM	TEMP C	IWC-SC G/M**3	IWC-CP G/M**3	IWC % CLD	DO UM	NT N/M**3	LMAX UM	FF	
22:19:00	9.0	-38.3	.0040	.0011	100	33	24468	250	.74	
22:19:15	8.9	-38.4	.0006	.0010	100	92	9625	311	.45	
22:19:30	9.0	-38.7	.0009	.0041	100	93	17653	311	.66	
22:19:45	8.9	-38.8	.0011	.0046	100	97	18778	311	.67	
22:20:00	9.0	-38.8	.0010	.0051	99	100	18414	437	.69	Just getting out of heaviest Cs. Visibility has improved to about 15 mi on slant downward. At 34° 31'N, 104° 26'W. Heading 333°.
22:20:15	9.0	-38.8	.0007	.0029	100	78	20262	311	.68	
22:20:30	9.0	-38.8	.0007	.0021	100	76	16850	250	.69	
22:20:45	9.0	-38.7	.0003	.0009	100	88	6426	311	.56	
22:21:00	9.0	-38.6	.0009	.0040	100	79	25582	311	.70	
22:21:15	9.0	-38.8	.0007	.0026	100	72	20015	311	.65	
22:21:30	9.0	-39.0	.0011	.0046	100	84	25618	311	.66	
22:21:45	9.0	-39.1	.0008	.0035	100	88	16463	311	.67	
22:22:00	9.0	-38.8	.0001	.0004	100	97	2311	311	.56	
22:22:15	9.0	-38.8	.0001	.0009	100	69	8987	311	.65	
22:22:30	9.0	-38.9	.0003	.0010	100	56	15489	209	.76	Getting out into open again. Cs is on right.
22:22:45	9.0	-38.8	.0018	.0032	100	46	70247	311	.67	
22:23:00	9.0	-38.8	.0003	.0016	100	60	19464	209	.76	
22:23:15	9.0	-38.9	.0002	.0010	100	63	9836	311	.67	
22:23:30	9.0	-38.9	.0005	.0021	100	65	20629	311	.66	Good sampling area for thin cirriform filaments. Pretty much in clear. Will move over closer to the cloud band.
22:23:45	8.9	-38.9	.0002	.0016	100	55	22644	209	.83	
22:24:00	8.9	-38.8	0.0000	.0009	100	52	12734	148	.91	
22:24:15	8.9	-38.8	.0000	.0009	100	60	11466	189	.85	
22:24:30	8.9	-38.8	.0000	.0007	100	53	9447	169	.89	
22:24:45	8.9	-38.8	.0000	.0010	100	61	9797	209	.91	
22:25:00	8.9	-38.7	0.0000	.0009	100	54	10985	209	.84	
22:25:15	8.9	-38.6	0.0000	.0010	100	59	12492	209	.82	
22:25:30	8.9	-38.6	.0002	.0007	100	58	8653	209	.81	
22:25:45	8.9	-38.7	.0001	.0014	100	59	15620	230	.82	
22:26:00	8.9	-38.7	.0000	.0015	100	57	17747	230	.82	
22:26:15	8.9	-38.8	.0000	.0015	100	59	16660	209	.85	
22:26:30	8.9	-38.8	.0000	.0014	100	56	16679	230	.86	
22:26:45	8.9	-38.8	0.0000	.0011	100	58	11507	209	.90	
22:27:00	8.9	-38.8	0.0000	.0011	100	54	12814	209	.88	Moving closer. Very few counts in ASSP.
22:27:15	8.9	-38.7	0.0000	.0008	100	58	8491	230	.87	
22:27:30	8.9	-38.7	.0002	.0008	100	55	11513	230	.83	
22:27:45	8.9	-38.7	.0001	.0007	100	56	9226	209	.84	
22:28:00	8.9	-38.7	.0002	.0009	100	58	11011	209	.85	
22:28:15	8.9	-38.7	.0001	.0008	100	60	9455	209	.84	
22:28:30	8.9	-38.7	.0002	.0006	100	51	10615	169	.84	
22:28:45	8.9	-38.7	.0002	.0005	100	53	8804	189	.77	
22:29:00	8.9	-38.7	.0003	.0006	100	47	13400	209	.82	Nearly clear air. Cu below and to right. Blue sky above.
22:29:15	9.0	-38.8	.0000	.0003	100	55	3609	148	.94	
22:29:30	8.9	-38.8	0.0000	.0002	100	55	2967	148	.87	At 34° 40'N, 104° 33'W. Thin Ci uncinus ahead, but may be too high to sample. Heading 232°.

Appendix D

List of Abbreviations

Ac	- Altocumulus
AFB	- Air Force Base
AFGL	- Air Force Geophysics Laboratory
AFWL	- Air Force Weapons Laboratory
Alt	- Altitude (above mean sea level unless otherwise specified)
ART	- Airborne Radiation Technology
ASSP	- Axial Scattering Spectrometer Probe
C	- Cloud (or droplet) probe
^{o}C	- Temperature in degrees Celsius
Cc	- Cirrocumulus
Ci	- Cirrus
Cs	- Cirrostratus
Do	- Medium volume diameter
FF	- Form factor
GOES	- Geostationary Operational Environmental Satellite
g-m^{-3}	- Grams per cubic meter
Hdg	- Aircraft heading
IAS	- Indicated airspeed
IWC	- Ice water content
km	- Kilometer
L_{max}	- Maximum particle diameter

mb	- Millibar
MSL	- Mean sea level
MST	- Mountain Standard Time
NT	- Particle Density
1-D	- One-dimensional particle measuring system
P	- Precipitation probe
T	- Temperature
TAS	- True air speed
2-D	- Two-dimensional particle measuring system
UMT or Z	- Universal (or Greenwich) Mean Time
Z	- Calculated radar reflectivity

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